Salt Tectonics in the Southern Iran

Azar Khodabakhshnezhad¹, Mehran Arian²*

¹Department of Education, One Territory of Baharestan Education Office, Ministry of Education, Tehran, Iran
²Department of Geology, Science and Research Branch, Islamic Azad University, Tehran, Iran

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Abstract

Based on geographic distribution and geological setting of salt plugs in southern Iran, three salt diapiric provinces have been distinguished. These provinces include the Hormuz, Shiraz-Kazerun and Nyriz-Jahrum sub-basins. There are more than hundred salt plugs which they have been formed and developed in the southern margin of Iran. The salt structures that originated from Hormuz formation in these areas have been restricted and separated from each other for the first time in this paper. Salt diapirism of these provinces has been triggered earlier by Halokinesis in the Zagros and Persian Gulf basins, but it has affected later by tectonic forces, because orientation, shape and position of salt plugs have been followed from convergence regime (especially in the Zagros hinterland). In the other hand, based on our results from salt plugs in Persian Gulf foreland basin and the Zagros hinterland, Halokinesis triggers has been affected more than Halotectonic forces.

Keywords

Salt, Tectonics, Zagros, Persian Gulf, Iran

1. Introduction

The purpose of this research is clustering of salt plugs in the southern margin of Iran such as central Iran that it has worked by [1] [2]. The southern margin of Iran is including the Zagros orogeny belt and Persian Gulf [3]. The structural trends in Zagros province are north west-south east. It contains the fold and thrust belt that formed on the northeastern margin of Arabian plate [4]. Zagros Mountains have been terminated to the north of Minab city in Iran. Zagros hinterland is external platform of Arabian plate, from tectonics point of view. This mountain range is results of collision between Arabian and Cimmerian plates and thus it can be consider as an orogenic belt.

*Corresponding author.

More than 100 emergent salt structures, up to now, have been recognized in the Zagros mountain and Persian Gulf areas [5]-[7]. The most of emergent these salt structures are related to central and eastern part Zagros and Persian Gulf areas.

2. Materials and Methods

Hormuz Salt had been deposited within N-S and NW-SE trending troughs of the Arabian Basement in Late Precambrian-Early Cambrian. Also, Presence of Hormuz Salt in the western part of the Zagros Belt including the Abadan Plain is almost possible by geophysical data. Analysis of gravity data denotes negative anomalies beneath the structural highs. Also, seismic data are presenting additional evidences for upward movement of the Hormuz Salt which affected deposition of the younger sediments. Anticline structures of the Abadan Plain are formed above strike-slip fault systems. Salt walls or salt anticlines are probably emplacing core of the N-S trending structures. Upward movement of salt is due to curvature and step over along the strike-slip fault system and transtension [8].

The name of the Hormuz salt was taken from the Iranian Hormuz Island, cored by a salt diapir, which also gives its name to the opening strait of the Persian Gulf. The Hormuz formation [9] consists of 4 members and it is including salt, anhydrite, shale, siltstone, dolomite, sandstone, banded Hematite and volcanic blocks which are an evidence for volcanogenic genesis of salt formation model [10]. The Hormuz and equivalent series were deposited in an evaporate basin during the late Precambrian-early Cambrian [11].

Coeval salt basins crop out in a large domain including the eastern Zagros, Persian Gulf, Oman, Qatar, Central Iran, Pakistan, and northwest India [12]. Hormuz salt is supposed to be absent along the north-south trending Arabian arches, inherited from Pan African structures. Its initial thickness remains highly speculative: 900 - 1500 m for [13], 1500 m for [14], and 2000 - 4000 m for [15]. In the Fars domain of the eastern Zagros, this basal formation is covered by 7 to 9 km of sedimentary rocks [16].

The age of salt diapirism of Hormuz in the Zagros orogeny belt is very different and it has investigated by many workers such as [17]-[19]. Firstly, [20] suggested that most of the salt diapirs are pre-orogenic, and possibly had a prominent role in determining the location of folds during the Neogene Zagros orogeny.

This condition has confirmed by later researches such as [21]-[23]. Also, [24] proposed that the initiation of salt movement in Persian Gulf began during the Permian [25].

2.1. Tectonic History

The Zagros orogenic belt is a result of the Neogene collision between the Arabian and Cimmerian plates [26]-[28]. Tectonic column of the Zagros can be divided into at least, five tectonic stages [29] that existed between orogenic event at late Proterozoic (Pan-African), early rifting (intense chasmic in continental condition) event at Infra-Cambrian, late rifting event (quiet chasmic in marine condition) at Triassic and orogenic event at Neogene, that is related to continental collision.

The sedimentary succession in the Zagros is 6 - 18 km thick and ranges in age from Infra-Cambrian to Recent. There is a break up unconformity (the absence of Silurian and Carboniferous sediments) that is appropriate with [30] model for Passive margins evolution. Break up unconformity is coinciding with ocean floor spreading and sea transgression.

The northeastern part of Afro-Arabian plate margin began to undergo regional extension in the Infra-Cambrian to Carboniferous, finally caused to appear of a narrow oceanic basin between the Afro-Arabian plate and Cimmerian miniplate (Neo-Tethys) from the Carboniferous.

Then, post-rifting facies of passive margin from early Permian to the late Cretaceous were deposited on the Zagros basin. Since the late Jurassic, the Neo-Tethys ocean began subduction under the Cimmerian miniplate. A proforeland basin [31] formed at the NE margin of the Afro-Arabian plate from the Late Cretaceous, which it was accompanied to emplacement of Ophiolite rocks [32] [33]. The folding and regional uplifting of Zagros proforeland basin occurred at the end of Early Miocene. Therefore, Zagros is an active fold and thrust belt [34] same to Central Iran [35]-[38] and Alborz [39]-[43].

2.2. Geographical Position of Salt Structures

Salt diapirs of Zagros present a large variety of shapes and elevation from high relief to entirely eroded struc-
tures. In addition, they have different sizes at outcrop scale, ranging from craters a few km wide to diapirs and glaciers more than 5 km wide. These different morphologies are controlled by various factors, for example, position related to other structures, the time of emergence, the rate of salt dissolution, which is controlled by the rate of erosion, the bulk rate of salt emission from the source layer, and eventually by the tectonic activity [16].

The Salt plugs of the southern Iran can be divided into four areas, based on geographic distribution and geological setting of salt plugs (Figure 1):

1) The first area is central Zagros, with 23 emergent salt plugs.
2) The second area is southeastern part of Zagros, with 84 emergent salt plugs.
3) The third area is north margin of Persian Gulf, with 10 emergent salt plugs such as Hormuz, Larak and Abu Musa Islands.
4) The fourth area is an area between the first and second region in Zagros, with many subsurface salt plugs.

3. Results and Discussion

There are three diapiric provinces have distinguished (Figure 1).

![Figure 1. Geographical distribution of three diapiric provinces in Zagros. Locations of figures 2 - 8 are shown by red rectangles.](image-url)
3.1. The Diapiric Province of Hormuz

The diapiric province of Hormuz, in the east end of Zagros, with eighty four exposed salt diapirs is the widespread salt deporthrough in Zagros. Because, based on previous studies, such as [16], there are six type salt diapirs by investigation of the present-day surface morphology of them. They believe that nearly all the diapirs of the study area were already active prior to Zagros folding either as emergent diapirs forming islands in the Paleogene to Neogene Sea or as buried domes initiated at least by the Permian. They have been reactivated by subsequent tectonic events [44].

Therefore, only some of salt diapirs have been exposed in post-orogenic phase, and their shape and location have controlled by folds and faults interactions during orogeny (Figure 2). So, the most of salt domes on this province are pre-orogenic diapirs. Also, big salt glacier such as Mazijan salt dome with a very clear salt Fountain (Figure 3) is a general phenomenon in Hormuz diapiric province [44].

3.2. The Diapiric Province of Nyriz-Jahrum

The diapiric province of Nyriz-Jahrum, in the central Zagros is a small salt minibasin. It has got a few exposed salt diapirs, many blind domes such as Sim, Meymand, Bavush, Kharman (Figure 4), Kuh-e Gavbast anticline (Figure 5) and diapiric fold such as Kuh-e Bavush (Figure 5) that located on the west part of Hormuz diapiric province.

The Gavbandi High [33] has been formed the south termination of Nyriz-Jahrum province. The Gavbandi High has been formed by regional uplifting of northward continuation of the Qatar Arc towards Iran, during the Late Pre Cambrian - Early Cambrian. Therefore, there are not thick evaporate layer.

Figure 2. Interpreted ETM+ Satellite Image of salt diapirs and other structures in a part of Hormuz province. Map located in Figure 1.

Figure 3. Interpreted ETM+ Satellite Image of Mazijan salt dome with a very clear salt Fountain (Black circle). Map located in Figure 1.
3.3. The Diapiric Province of Shiraz-Kazerun

The diapiric province of Shiraz-Kazerun is located in the west part of Nyriz-Jahrum diapiric province. It has got twenty-three exposed salt diapirs and its area is smaller than Hormuz diapiric province.

The main north-south striking right-lateral faults in Zagros have been controlled location of this salt diapirs such as Kazerun fault with six, Kareh Bas fault [45] [46] with six (Figure 6) and Sarvestan fault with three salt diapirs [47]. It means that they are pre-orogenic salt diapirs, and their positions have been determinate current condition of folds [48] [49]. In addition, salt glacier such as Kuh-e Jahani dome (Figure 7), some blind salt dome such as Gardan anticline and diapiric fold such as Khaftar anticline (Figure 8) are general phenomenon in the Shiraz-Kazerun province.

However, based on previous study [50]-[52] and our investigations on the position, shape and orientation of salt domes in Zagros, three diapiric provinces have been introduced. Salt diapirism of these provinces has been...
Figure 6. Structural map in a part of Shiraz-Kazerun province. Map located in Figure 1.

Figure 7. Interpreted ETM+ Satellite Image of Kuh-e Jahani salt glacier. Map located in Figure 1.
affected by rift development during Paleozoic that it has accompanied with sedimentation of Banded Iron Formation (BIF) in Hormuz Group (Figure 9) on Zagros basin.

Finally, based on previous work on the neotectonic regime in Iran, Zagros in south Iran is the most active zone [53]-[73]. Then, North Iran nd Central Iran [73]-[83] have been situated in the next orders.

4. Conclusions

According to our results on the geographic distribution and geological setting of salt plugs in southern Iran, three salt diapiric provinces have been distinguished. These provinces include the Hormuz, Shiraz-Kazerun and Nyriz-Jahrum sub-basins.

Hormuz Salt is a member of the bigger rock unit (Super-group or Group) that, it had been deposited within syn-rift basins of the Arabian basement in Late Proterozoic-Ordovician.

Salt diapirism of these provinces has affected later by tectonic forces (especially in the Zagros hinterland which it has been recorded in orientation, shape and position of salt plugs), although it has been triggered earlier by Halokinesis in the Zagros and Persian Gulf basins. Also, extentional phase of Neo-Tethys rifting at early Paleozoic should be considered as the most important salt diapirism in the southern Iran. This rifting has been an important role on genesis of Banded Iron Formation that introduced in this paper at the first time.

The most of salt plugs are pre-orogenic emergent diapirs, thus they had got essential role in formation and development of the next structures during the Zagros deformation. However, progressive deformation has got an additional affects to reactivation of salt plugs.
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References


