# A NEW LIGHT ON DEVELOPMENT AND EVOLUTION OF MANN ANTICLINE EAST FLANK OF SALIN BASIN

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## Abstract

The Mann anticline occupies the northern part of the NNW-SSE trending first line of anticline structures known as Minbu-Htaukshabin-Tagaing-Chaungtha structural line which develops on the east flank of Salin Basin. It expresses on surface as anelongated, asymmetrical north plunging fault related anticline where Irrawaddian, Kyaukkok, Pyawbwe, Okhmintaung and Padaung formations as core were exposed and the northern plunging area of which is mainly covered by alluvium and Irrawaddians. Present study revisited the interpretations of gravity and dense seismic data and well to well correlations, as a result proposes a new light on the development and evolution of Mann anticline. From the gravity data it can be assumed that the northward plunge continues in the subsurface up to the latitude 20° 18′ about 8 miles from outcrop area; the anticline is intersected by two longitudinal faults, one on the western and the other on the east limb, and there exist a E-W transverse fault at latitude 20° 15′. The seismic images of the anticline suggest that Mann anticline is a strike slip fault related inversion anticline of positive flower shape bounded by west hading high angle fault zone on the east limb and syn-inversion antithetic faults on the west. The anticline is broad with gentle flanks in the north and the core of the anticline nose narrows to the south with steepening flanks. The structural analysis of the seismic data led to the conclusion that two phases of structuration took place in Minbu area. The first phase was E-W compression in Late Oligocene and formed proto Mann anticline with a NNW-SSE trending oblique longitudinal normal fault along the crestal portion. The second phase is the dextral strike slip faulting initiated from Pliocene and continues to recent which caused inversion of the existing structures resulted in current positive flower shape configuration of Mann anticline. Over 600 wells were drilled on the Mann anticline to date and the well to well correlations confirmed existence of cross and oblique normal faults and longitudinal reverse faults which have effective sealing potential and compartmentalizing the anticline into numerous oil pools. The Sabwet Chaung indicated by gravity low anomaly is a zone of high angle conjugate normal faults dipping towards each other and separated Mann anticline from Htaukshabin Anticline. It may possibly has an active strike slip component and forming a passage through which the clay intermingled with water and gas seeps to the surface as small mud volcanoes at Nagapwet Taung.

**Keywords:** seismic, attribute

## Introduction

The Mann anticline is located in the Minbu District, Magway Region, between latitude 18° 10′ to 18° 18′ and longitudes 94° 45′ to 95° 0′, covering about 10 square miles (6400 arces). The Mon Chaung is the northern boundary and the Sabwet Chaung is the southern boundary. (Figure - 1) The area north of latitude 18° 14′ is a flat plain with average elevation of 140 ft above sea level covered by alluvium. The area between latitudes 18° 14′ and 18° 10′ is a fairly rugged terrain with average elevation of 250 ft covered by Miocene to Oligocene rocks.

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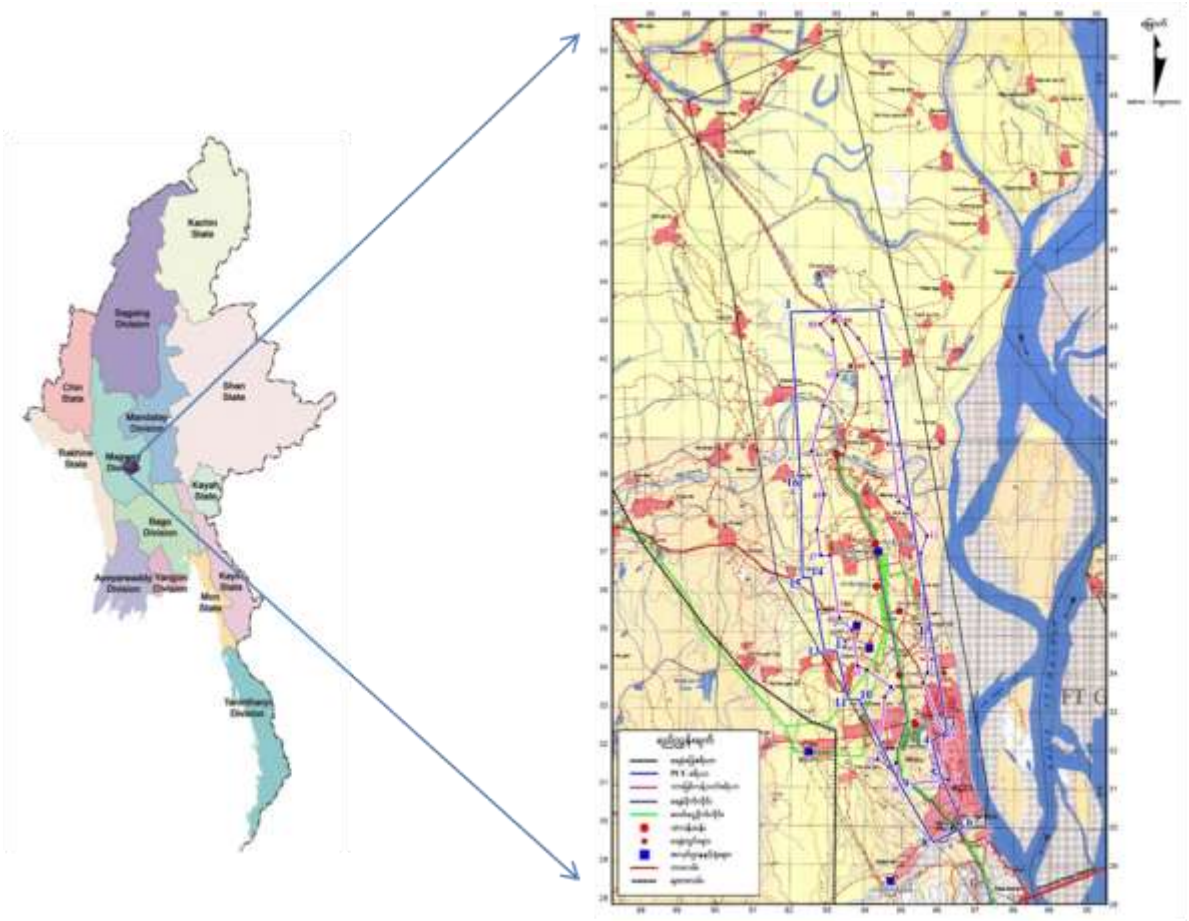

**Figure 1** Location map of Mann anticline

## Geological Interpretation

The Mann anticline occupies northern crestal area and northern plunging area of the Minbu anticline. The Minbu anticline is an asymmetrical, elongated anticline continuing from the Tagaing-Chaungtha structural trend through Peppi, Palanyon, and Htaukshabin to Minbu with the NNW-SSE trend. The Minbu-Taggaing- Chaungtha anticlinal structure trend is the first line of structure reference to the Salin Syncline developed on the east flank of Salin Basin (figure-2). The Sabwet Chaung fault located at the latitude 18° 10′ divided Minbu anticline into two anticlines namely Mann anticline and Htaukshabin anticline.

Mann anticline is a broad-crested, asymmetric, cross and crest ally faulted anticline bound to the east by the west hading thrust. The dips are as high as 70° on the west flank and rarely exceed 30° on the east flank. The nose of the anticline and most of the crestal area have dips in the range 10° -15°.Geological map of the Mann anticline is shown in figure(2).

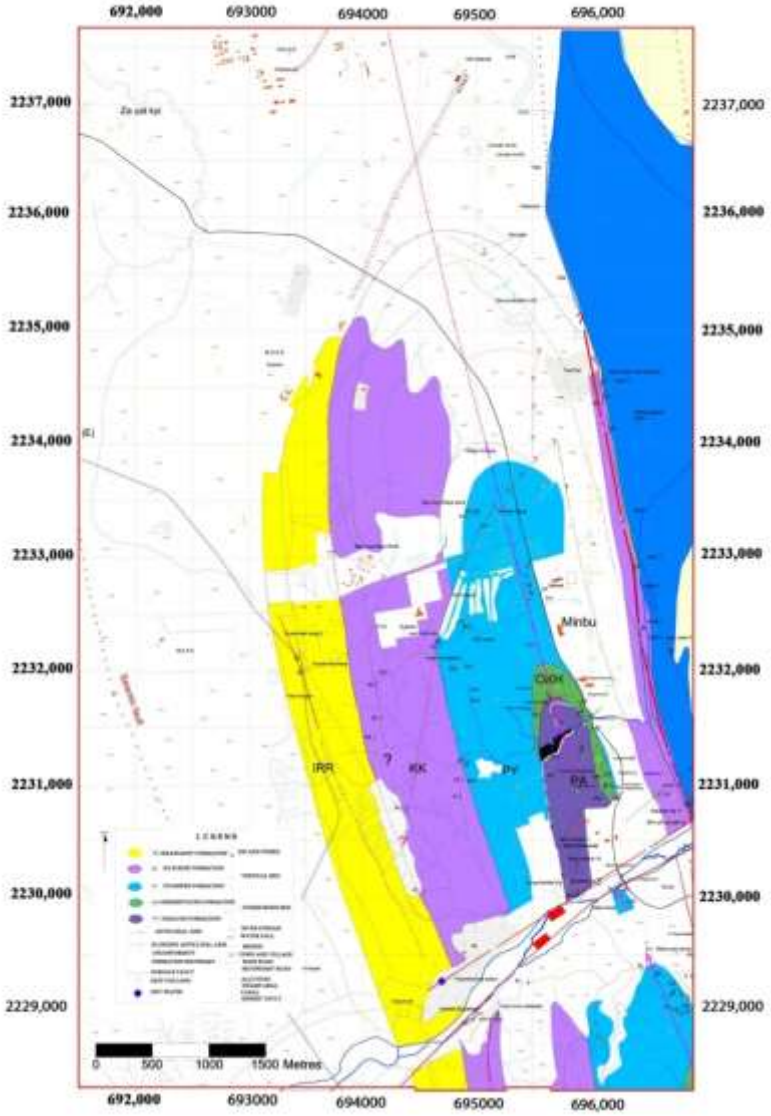


**Figure 2** Geological map of Mann anticline(source: MPRL E&P )

The tectonic map of the east flank of Salin basin including Minbu anticline is display in figure 3.

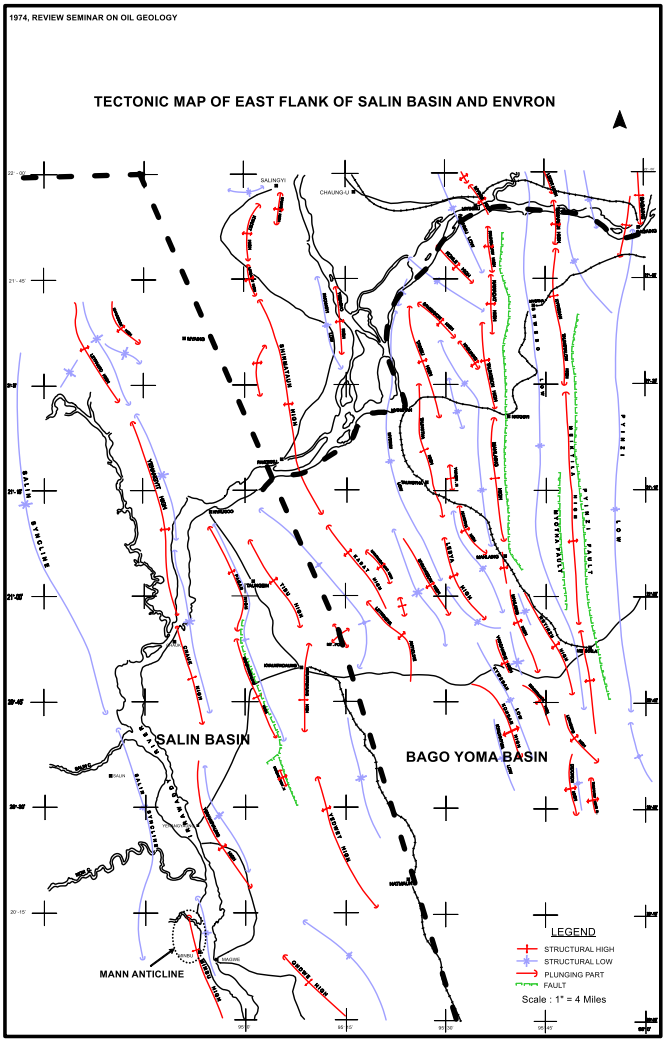


**Figure 3** Tectonic map of east flank of Salin Basin.(source : POI, 1966)

## Gravity Interpretation

In 1966, a detailed gravity survey using Worden Gravity meter 753 was conducted by the People's Oil Industry (POI)in the northern Minbu area covering an area of 64 square miles with a total of 171 gravity stations composing of two N-S lines and thirteen E-W lines. The gravity anomalies have a general NNW-SSE trend and three gravity low zones are separated by two gravity high zones (Minbu High and Paukkon High). Bouguer gravity profile indicate that gravity value increase towards the east, culminating over the Minbu gravity high and decrease toward the east of Minbu. (Figure 4 )

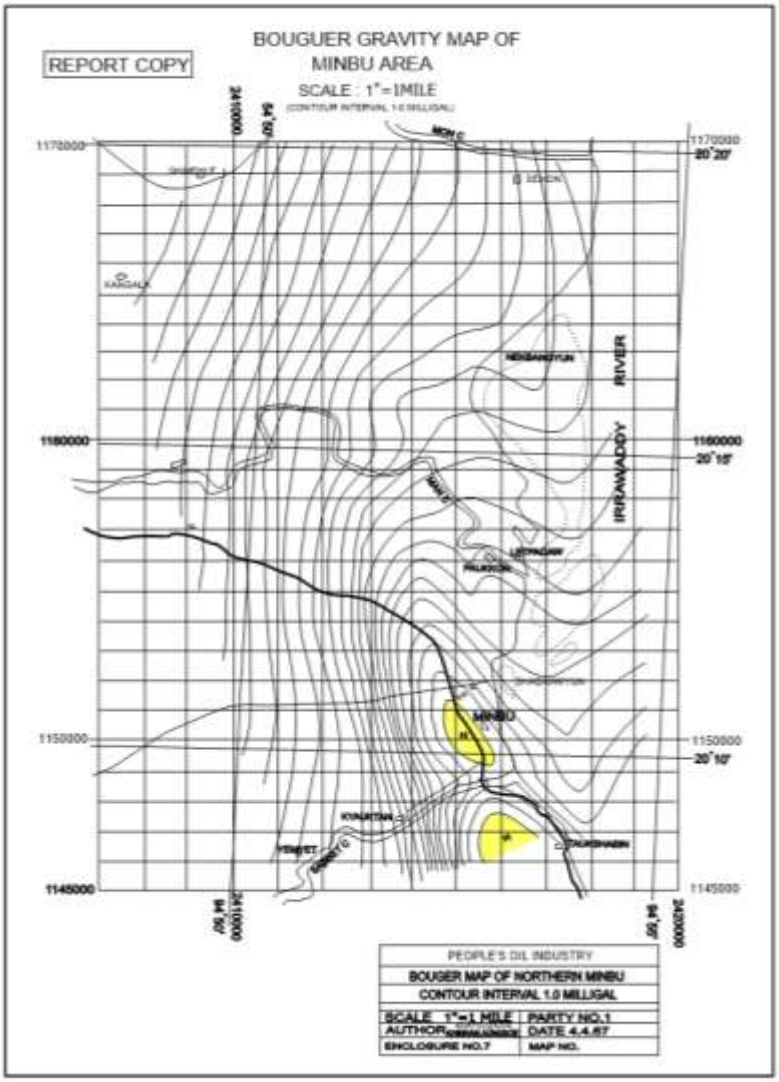


**Figure 4** Bouger gravity map of Mann Anticline (source : People's Oil Industry, 1966)

The residual gravity profile shows that with the gentle gradient of 1 milligal/ mile the profile steepens abruptly at the middle part of the western side to 3 millgal/ mile up to highest part of at Minbu. Then the profile decreases again with a gradient of 2.2 milligal/mile and formed a minor culmination at the middle part of the eastern side at Paukkon high. And decreases again with same gradient to the eastern boundary of the survey area.

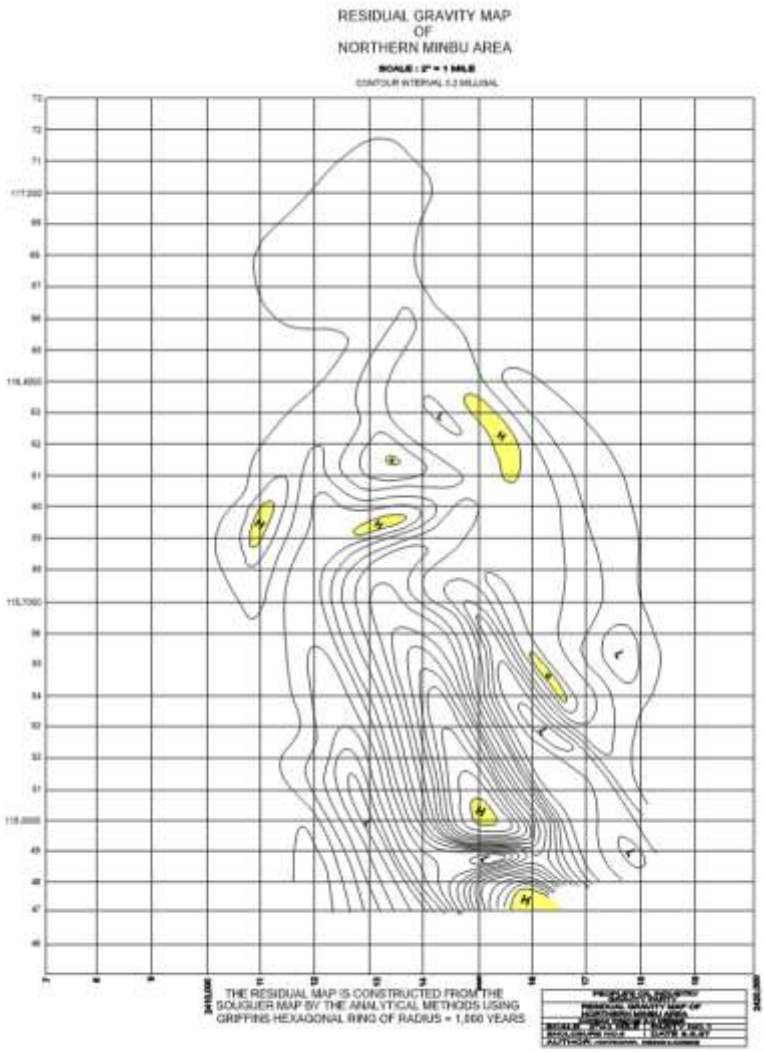


**Figure 5** Residual gravity map of northern Minbu area. ( Source: People's Oil Industry, 1966)

From the result of the gravity survey, two anticlinal structures are recognised i.e., Mann Anticline and Paukkon Anticline. From the gravity profiles, the western flank of the Mann anticline is found to be more gentle than the east flank . The contours forming closures at the north of Minbu indicate that the northward plunge is still continues in the subsurface up to the latitude 20° 18′ (about 8 miles further north of Shwelinban field). Two longitudinal faults are assumed to intersect the structure, one on the western and the other on the eastern limb. The fault zone on the eastern limb can possibly be occupied by a series of faults as assumed from the steep gradient in the bouguar map.

Two probable transverse faults are considered to exist also, the southern one at latitude 20 ° 10′ coinciding with the course of Sabwet chaung indicated by the gravity contours forming a saddle, and the northern fault at the latitude 20° 15′ suggested by the east west trending gravity low areas separating the high zone into two parts in residual map.The fault zone at Sabwet Chaung may possibly formed a passage through which the clay intermingled with water and gas excapes to the surface.

## New Interpretation

In the regional tectonic sense, the Salin Basin is a forearc sub-basin of the Central Myanmar Tertiary Belt and experienced two phases of deformation. The first phase is east-west compression which took place in upper Oligocene. The second phase is an inversion phase (transpressional deformation) induced by dextral strike slip movement of the Sagaing and Kabaw faults which initiated in early Pliocene and continues to Recent.

Since the Mann anticline is a northernmost part of the Minbu-Tagaing-Chungtha line of anticlinal structures which is a first line of structure developed on the east flank of Salin Basin, it had undergone above said two phases of structurations. The present day configuration of Mann anticline is an inversion anticline bounded by west hading reverse fault zone on the east flank and east hading antithetic fault on the west flank. (major fault in previous interpretation in figure-6)

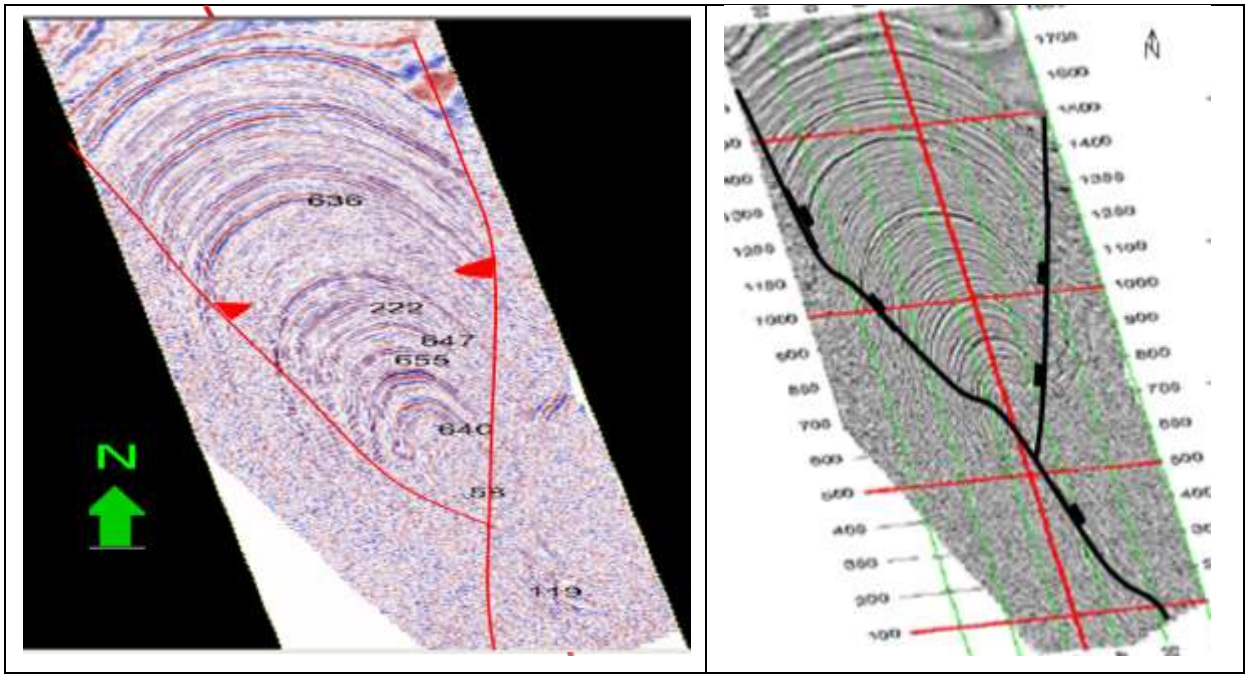


**Figure 6** Time slice section of Mann inversion anticline forming a positive flower shape.(Modifiedfrom MPRL E&P,2009)

## Development and Evolution of Mann Anticline

The integrated structural analysis using surface geology, gravity, well logs and seismic data shed the new light on development and evolution of the Mann anticline as follows:

1. The cyclic deposition of coarse grained and fine grained sediments took place from Paleocene to late Oligocene (Kabaw, Paunggyi, Laungshe, Tilin, Tabyin, Pondaung, Yaw, Shwezetaw, Padaung and Lr. Okhmintaung formations), on the Mesosoic acoustic basement in the Salin Basin including Mann area.

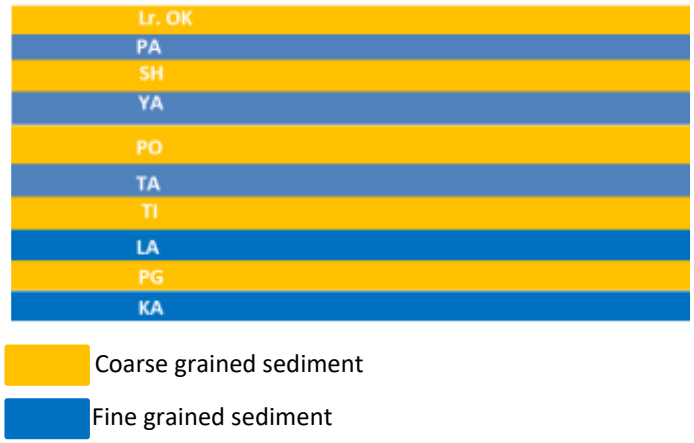


**Figure 7** Cyclic sedimentation of coarse and fine grained sediments in Salin Basin from Paleocene to upper Oilgocene

2. During late Oilgocene, the collision of India plate and Burma plate created east-west compression and formed proto Mann anticline. The subsequence tensional movement created NNW-SSE oblique longitudinal normal fault near the crestal part on the east flank .

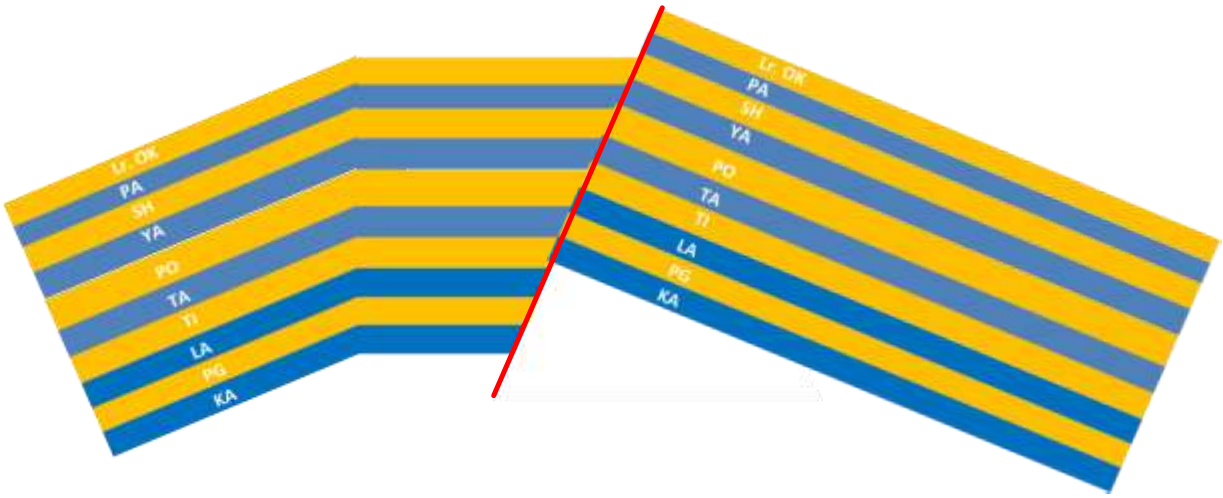


**Figure 8** Proto Mann Anticline with longituidinal normal fault in upper Oligocene time.

3. The Salin Basin subsided again and continued cyclic sedimentation from late Oilgocene to upper Miocene (Pyawebwe, Kyaukkok, Obogon formations).
4. The terrestrial sediments ( Irrawaddian Fm) were deposited from upper Miocence to Pliocene.

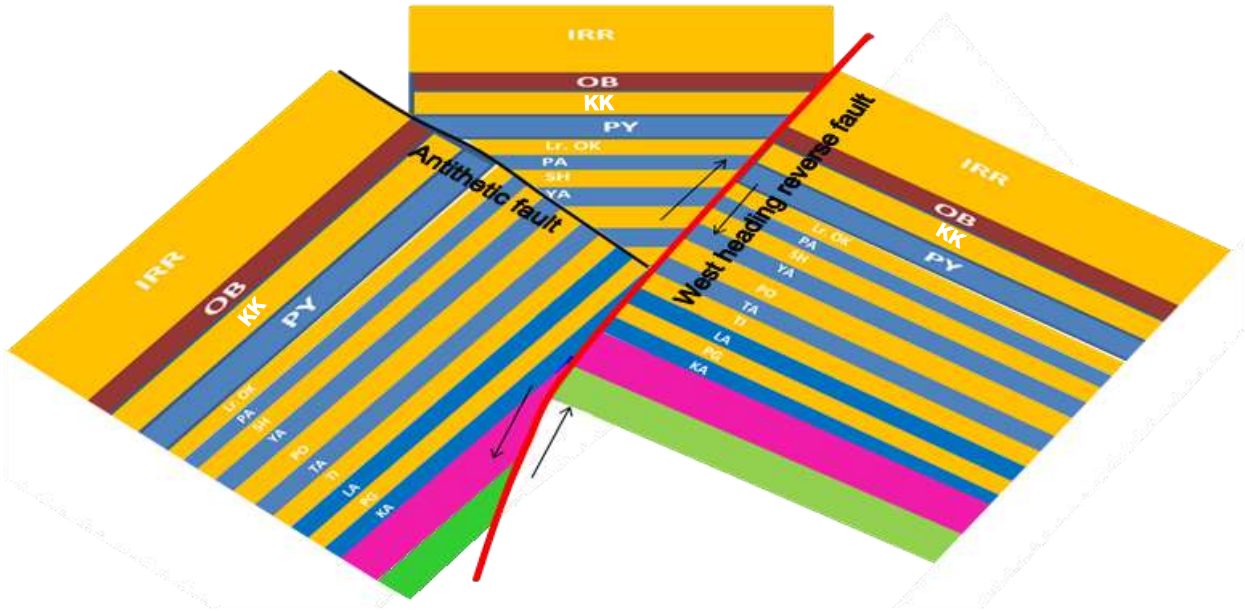


**Figure 9** Inversion of Mann Anticline during Pliocene to recent.

5 The inversion of the existing structures in Salin Basin initiated in early Pliocence and continues to recent. The present day structural configuration of Mann anticline is a result of this inversion phase.The evidence of inversion anticline is that the west hading reverse fault becomes normal fault in the deeper part.( Figure 14 & 15)

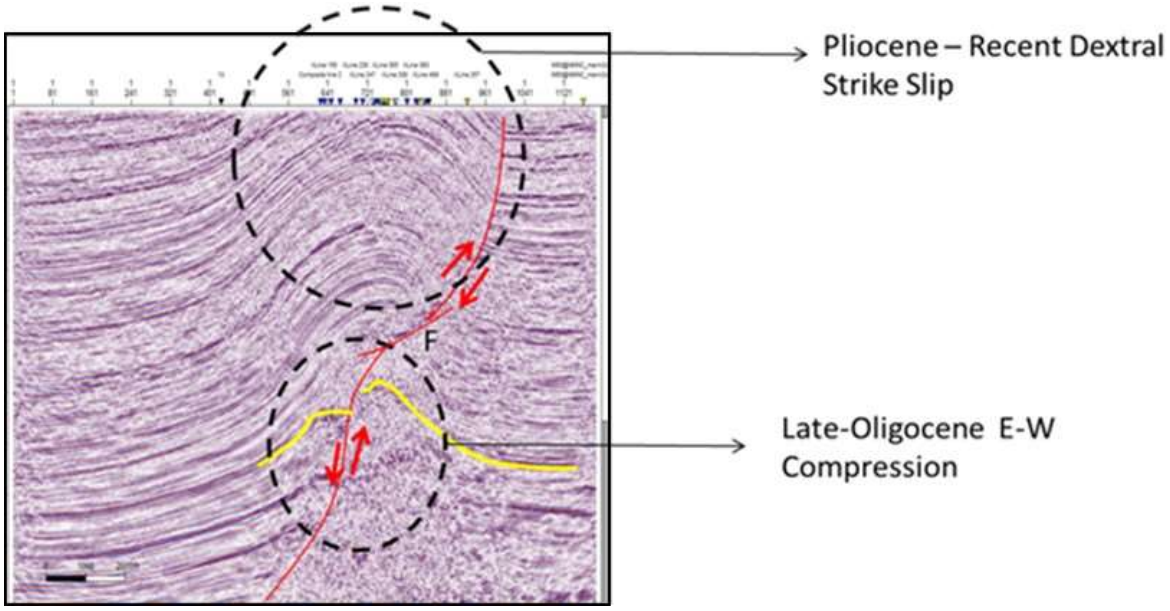


**Figure 10** Structure evolution of Mann Anticline.(modified from MPRL E&P )

## Conclusion

The 3D seismic images of the northern part of Mann anticline clearly indicate that Mann anticline is an positive flower shape inversion anticline. In the southern part it becomes tight and complex due to development of many syn-inversion antithetic faults. The present day oblique longitudinal normal fault "B"which rooted to basement as per gravity data interpretation strongly support the idea on formation of NNW-SSE longitudinal normal fault ( west hading major reverse

fault of present day) in proto-Mann anticline. The mud volcanoes in the southern part especially at Nagapwet Taung are formed by the seepages of clay intermingled with water and gas along the fractures which may possibly caused by active strike slip movement. Further high resolution 4D seismic survey or 4C seismic survey will improve understanding on structural geology of Mann anticline and the whole basin.

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