

The neotectonic map of Iraq

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Abstract

A neotectonic map of Iraq was constructed according partly to the work of Soviet team during eighties of the last century. The lower surfaces of Upper Miocene are chosen to be a datum for the construction. This is because the mentioned datum was considered to be surfaces or phase of tectonic stability leading one to calculate the intensities of down warping and up warping movements with their associated rates. The mentioned intensities and rates are represented by isoclinal on the constructed map. The constructed map depended on relatively recent available data from oil wells and surface geological surveying. Four supplementary maps established surrounding the constructed map for the purpose of comparison.

Introduction

Neotectonics is defined "as the movements of earth's crust that have taken place during the Late Tertiary and Quaternary period, Vita Finzi, 1986, moreover the mentioned movements play decisive role in the formation of the contemporary topography and should fully explain the chief features of contemporary topography of the entire globe, obruchev, 1948. A neotectonic map is a map showing active (and potentially-active) structural features such as faults and folds in addition to values of deformations (up warping and down warping movements). Many countries construct a neotectonic map since long time, for instance the former USSR presented a neotectonic map, showing the warping of crust in the form of isolines, since 1960 of last century. AEE, 1985 presents a preliminary neotectonic map of Iraq as a part of the requirements of site selection of nuclear power plant. As a result, the mentioned work was the setup point to a series of neotectonic works in Iraq, including the present map, though some Iraqi researchers handle the subject from different point of view. The present map is constructed from the following best available surface and subsurface data.

- +available drilled oil wells
- +data of geological survey of Iraq
- +Data gained from tectonic map of Iraq
- +Seismological data i.e. the epicenter of earthquakes.

Except the above first item, data are exhibited as auxiliary maps to complement the whole picture. These are: tectonic map, rate of movement map, geochronological map and earthquake epicenter map.

Theoretical background

The most important issue in this type of work is how to select a suitable level from which the neotectonic activity can be measured, as accurate as possible, based on sensible and scientific bases. AEE, 1985 established a base for the above concern. This group of workers selected the Middle-Upper Miocene boundary (Target) as the start point of the neotectonic boundary in Iraq (approximately 11.60 Ma). This is due to:

- * Intensification of ascending tectonic movements in north Iraq in the mentioned boundary.
- * The change in the sedimentation conditions (depositional environment) in down warping areas occurring at the boundary of Middle-Upper Miocene.

The Predominance of carbonate and halogen sediments in Oligocene and early Middle Miocene sediments is an indication that the level of the mentioned sediments are not much elevated from sea level and their heights was within some dozen of meters ,as well the shallow marine basin was shallow water. With the beginning of Upper Miocene the sedimentation conditions abruptly changed .The areas and heights of out-wash regions significantly increased so that small sized molasses-like sediments and thereafter more rudaceous sediments became sharply Predominate. As a result, all events within post M. Miocene should be considered within neotectonic activity including the last phase of Alpine Orogeny. According to A. Becher, 1993 the neotectonic period in central and northern Europe might be sensibly regarded as having begun approximately 10 Ma ago in the early late Miocene. Thus both mention authors attains approximately the same neotectonic period. This may support the chosen boundary in the present work by knowing that each area has its own characters.

Consequently, the main procedure in construction of the present map is to follow the contact between the Fatha (Lower Fars) and Injana (Upper Fars) Formations or its equivalent. The Target reflects the gradational change from marine/lagoon to fluvial/continental environments and reflects the sea level in that time which is very near to the present sea level. Thus the constructed contour relative to mentioned sea level (zero value) expresses the disturbance in the form of sea level.

Methodology and scope of the work

The present map is constructed from best available surface and subsurface data by the authors. The main idea is to construct isolines by means of which the height of the "Target", from sea level, is demonstrated. The method of work can be summarized in the following paragraphs:

1. The height of hundred of outcrops representing the "Target" was documented. These were estimated from geological maps of 1:100000 mainly, although maps of 1:25000 on scale was used. The effect of erosion is ignored because the effect is not constant overall the country and the scale of the work is 1:1000000.

2. The elevation of the "Target" was determined from 119 oil wells in the areas where the target is not exposed at the surface especially in the Mesopotamian plain. The data was provided from Oil Exploration Company.

3. Because Injana (U.Miocene) and or Fatha (U.Miocene) Formations is not exposed constantly all over the country and they are studied and documented extensively , thus the estimation of "Target" was as follow:

- In case when Injana formation is not expressed or even not deposited but Fatha Formation existed, the top of Fatha Formation is documented.
- In case when Fatha Formation is not expressed, the base of Injana Formation is considered as: "Target".
- If both formations are not expressed, the "Target" was estimated reasonably by drawing hypothetical contours and compiled with nearby area of well defined "Target".

4. More than ten cross sections were constructed in the areas where no surface and subsurface data are available related to the "Target". To indicate the depth of the 'Target', depending on geological maps and enclosed reports.

5. In the southern and western parts of Iraq where Injana Formation is not exposed or even not deposited, the "Target" is considered at the base of Zahra and/or Dibdibba Formation, only when they form continuous outcrops and not scattered ones. Assuming that this contact is the best age equivalent to the target.

6. In the northeastern parts of Iraq, The base of the Red Beds Series was assumed as the best age equivalent of the(Target)for purpose of contouring.

7. Due to inadequate data and scale limitation, the contour interval couldn't be kept constant over the entire constructed map especially in the folded area.

8. In the Mesopotamian plain, due to lack of subsurface data (oil well), the shape of the constructed contours does reflect all existing subsurface structures. Therefore, the shape of the constructed contours reflects the main subsided basin within which many uplifted (anticlines) areas are certainly present. However for regional scale, the shape of the contours is sufficient.

9. All existing main thrust faults in the Foot hills Zone are presented and taken in consideration, during construction of the contours.

Calculation the Rate of Movement

The subsidence and uplift rate (during neotectonics) is calculated from the constructed Neotectonic Map of Iraq. The time interval of the upper Miocene is 11608000 years (Gradstein et al., 2004), for simplification purposes it is considered to be 12000000 years. Then, each 500 m. of contour interval (from the constructed map) is selected, because the contour interval is not constant. By dividing the time interval by the selected contour interval the rate of movement each 100 years was determined and it is found to be 0.4cm per 100 years. Hence, each contour interval of 500m (within the constructed map) is given an amount of 0.4cm movement. It is called "Rate of Movement Map", it shows the uplifted and down warped areas with the rate of movement as being measured by centimeters per 100 years. The main aim of this map is to know the more calm areas, within the whole territory, which could be used for strategic site selection and/or their ranking.

Description of the present map

The size of the original map sheet is equal to the well known geologic and tectonic map of Iraq scale 1:1000000. The enclosed map i.e. neotectonic map is surrounded by four supplementary maps. These are:

- Tectonic map of Iraq scale 1:6000000 constructed by Al-Kadhimi, 1996
- Geo-Chronological map scale 1:6000000 modified from Jassim et al, 1980.
- Earthquake epicenter map scale 1:6000000 constructed in this work from recent available data.
- Average movement map scale 1:6000000 constructed in the present work.

This map is one from the series of related Earth science map of Iraq scale 1:1000000 which are designated, printed and published by *General Company of Geological Survey and Mining GEOSURV*. The authors spent

two years (1996-1998) to construct the target map. The map has a legal deposit: 364/1998 (sheet No.10) in the National Iraqi Library/Baghdad. Many references are used during compilation of the present map and fixed on the original map, see references. As it is, the present map describes itself, thus there is no need to go through it. However, it is worth to give some figures (intervals) dealing with the intensity of warping for some known tectonic zones and areas:

- Stable Shelf Area.....Positive*..... 50-800m.
- Mesopotamian Zone....Negative*.....0-2000m.
- Low folded Zone.....Positive Example:
Hamrin anticline...> 250m.Negative.....Example: The area between Kirkuk and Hamrin anticlines...maximum subsidence reaches 2000m.
- High folded zone....Positive..... maximum uplift attains 1000m. and average uplift is 750 m.
- Thrust zone.....positive..... 1250-1500m.

Review of the Neotectonic History

Although data concerning neotectonic history in Iraq is very inadequate, a brief review is given for the whole territory, based on the constructed map from updated data. (see the figures for necessity)

- The last folding amplitude that have been formed during the Late Alpine Orogeny (Late Miocene-Pliocene) and most probably extended to Pleistocene, as it is indicated from folding of Bia-Hassan Formation and partly folding of terrace of Tigris River near Khanouqa for example, this phase is presented within this map.
- The difference in the amplitude of folds of the thrust and High Folded Zone indicates the migration of the stresses by orogenic movement southwest and southwards, in northeastern and northern parts of Iraq, respectively. The amplitudes are +1000 m. to more than +1250m.
- During Late Miocene-Pliocene, the Low Folded Zone involved to the Orogeny. The stresses migrated to this zone and acted differentially in specific area, causing wide synclines, with downwarping to 4000m. and narrow anticlines, with uplifting to +400m associated locally with reverse faults of moderate to high angle.

*positive means uplifted area, that the target contact located above the datum (zero level)

*Negative means subsiding area that the target contact located below the datum (zero level)

- The Mesopotamian Zone is considered to be successively down warping, but the major stresses that caused the present form of topography and folding started in Pliocene and are evidenced by the presence of folded strata of Bia-Hassan Formation within this basin. The maximum downwarping attains -2500m.
- The stable shelf is relatively less affected by the Alpine Orogeny. However, many faults are recorded by Al-Mubarak and Amin, 1983 to be affected on Pliocene-Pleistocene sediments in the western desert, like Zahra and Dibdibba Formation.
- The last phase of Alpine Orogeny, which has began in Miocene and continued to early Pleistocene was not abruptly diminished. However, it is most likely to say "it was extensively attenuated". This means it is still ongoing or active
- Many surface evidences of this activity have detected other stand to be detected and need further detailed studies. Topographic expression of subsurface structures like Samarra, Tikrit and Balad and the dislocated terraces in the folded areas are considered good examples of aforementioned activity. Therefore, it could be briefly concluded that two main forces are still active, these are:
 - +The attenuated phase of the Alpine Orogeny, which is considered as "epirogenic movement"
 - + The spreading result of the Red sea (northeastern wards movement of the Arabian Plate and its collision with the Eurasian Plate), which is proved to be active.

Uses of the Neotectonic Map

The implication for compilation of the present map passes through:

- The instant necessity of such map as "Preliminary map" to locate the area which requires further detailed neotectonic studies for strategic projects i.e. in site selection and their ranking by the way clarifying the subsided and uplifted areas their amount besides, demonstration of the main active and capable fault, which are presented on the geological map all those which have affected the geological units of Upper Miocene and younger, in age. All mentioned features have direct relation to safety factors.
- The significant involvement of the present map in better understanding the tectonics aspects of the country in general and in compilation of the other related maps like "seismotectonic map"
- To open the doors for deep and series debate concerning neotectonics.

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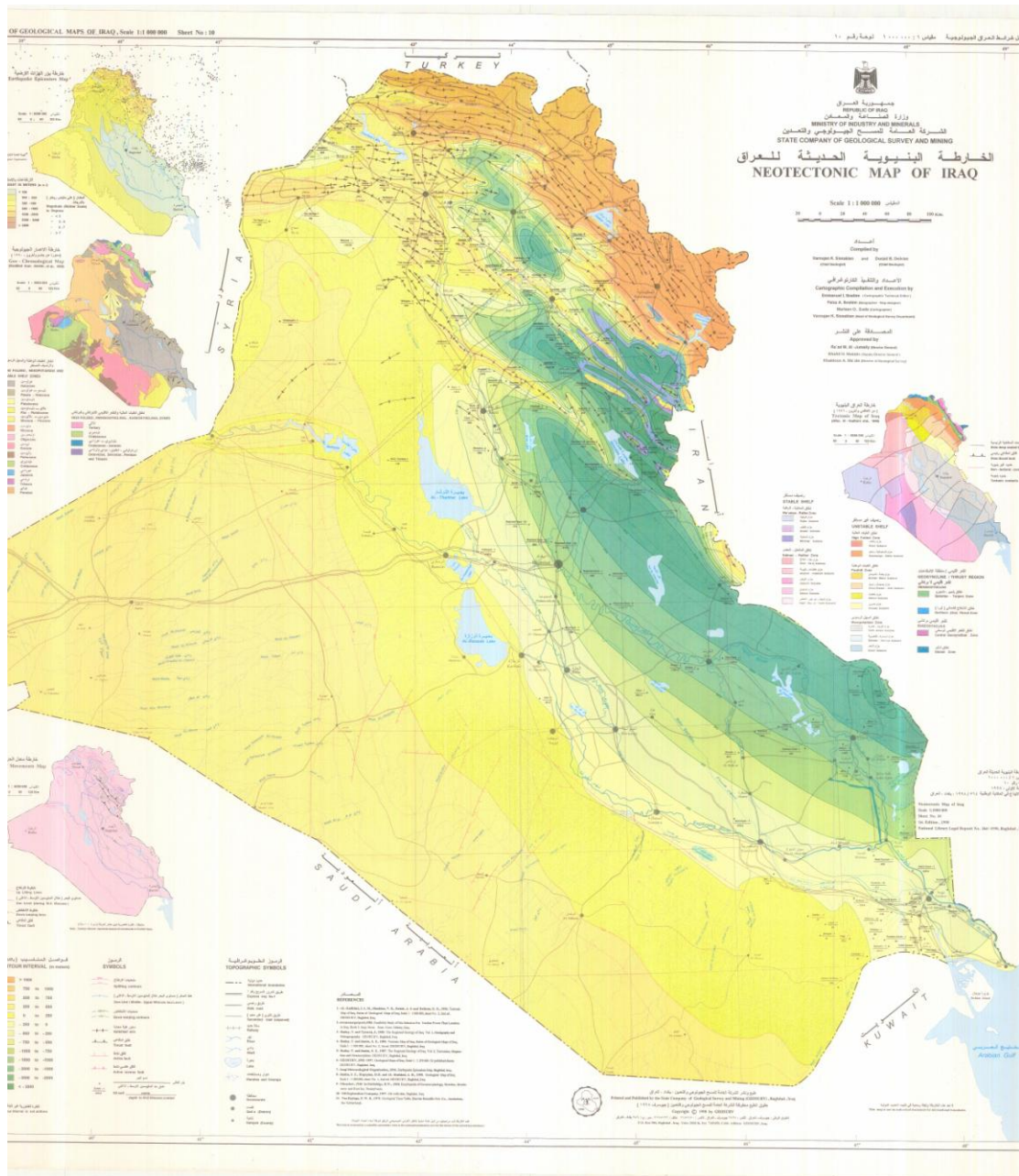


Fig.(1): The neotectonic map of Iraq

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الخارطة النيوتكتونية للعراق

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الخلاصة

أعدت الخارطة النيوتكتونية للعراق نسبة لعمل الفريق السوفيتي خلال عقد الثمانينات من القرن الماضي. كان السطح الأسفل للمايوسين الأعلى مرجعا لهذا العمل لأنه اعتبر سطحاً أو طوراً تكتونياً مستقراً مما سهل عملية حساب سعة الصعود والهبوط وما تلازمهما من معدلات. وقد تم رسم ذلك على الخارطة بواسطة الخطوط الكنتورية. اعتمدت الخارطة على أفضل البيانات الجيولوجية من الآبار المحفورة والمسح الجيولوجي السطحي. إن الخارطة الرئيسية أحيطت بأربعة خرائط سائدة وهي : خارطة العراق البنيوية وخارطة بؤر الهزات الأرضية وخارطة الأعمار الجيولوجية وخارطة معدل الحركات.