Some neotectonic notes on the selected topographic expressions between shari and tharthar lakes Central iraq

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Abstract

The goal of this paper is to clarify type, intensity and rate of movements, of topographically expressed features, by evaluation of surface and subsurface data through three cross sections in central part of Iraq. This was attained conveniently by comparing the selected contacts, within neotectonic time, with their original heights represented by global sea level heights and with contemporary topography. The chosen sea levels are assumed to be the original position of the undisturbed contacts. The present study assumed that any departure from the unique sea level could be caused by vertical movement (uplift or subsidence).

Four topographically expressed features are included within three cross sections, each of them has specific stratigraphic boundary and unique sea level. These are: topographically expressed fetures of Samarra and Salahaldeen structures beside Shari and Tharthar Lakes. In addition, the sections includes: contemporary topography and the contacts of ; Middle/Late Miocene, Late Miocene/ Pliocene and Pliocene/Pleistocene, derived from geophysical depth maps with their associated global sea level. The first contact represents phase of tectonic stability but the other two are not , they are involved in this study to clarify and to be more close to the neotectoic events.

Introduction

The studied section is situated in the central part of Iraq. It forms a straight line connecting Shari Lake in the ENE and Tharthar Lake in the WSW direction. It passes through topographically expressed features: Samarra and Salahaldeen, in addition to Shari and Tharthar Lakes, Figure 1.

-Geologic setting

Tectonically, according to Al-kadhimi et al. (1996) the studied section lies within Tigris Sub Zone. The mentioned sub zone is a part of the Mesopotamian Zone of Unstable Shelf lying altogether within the NE region of the Arabian Plate, figure 1.

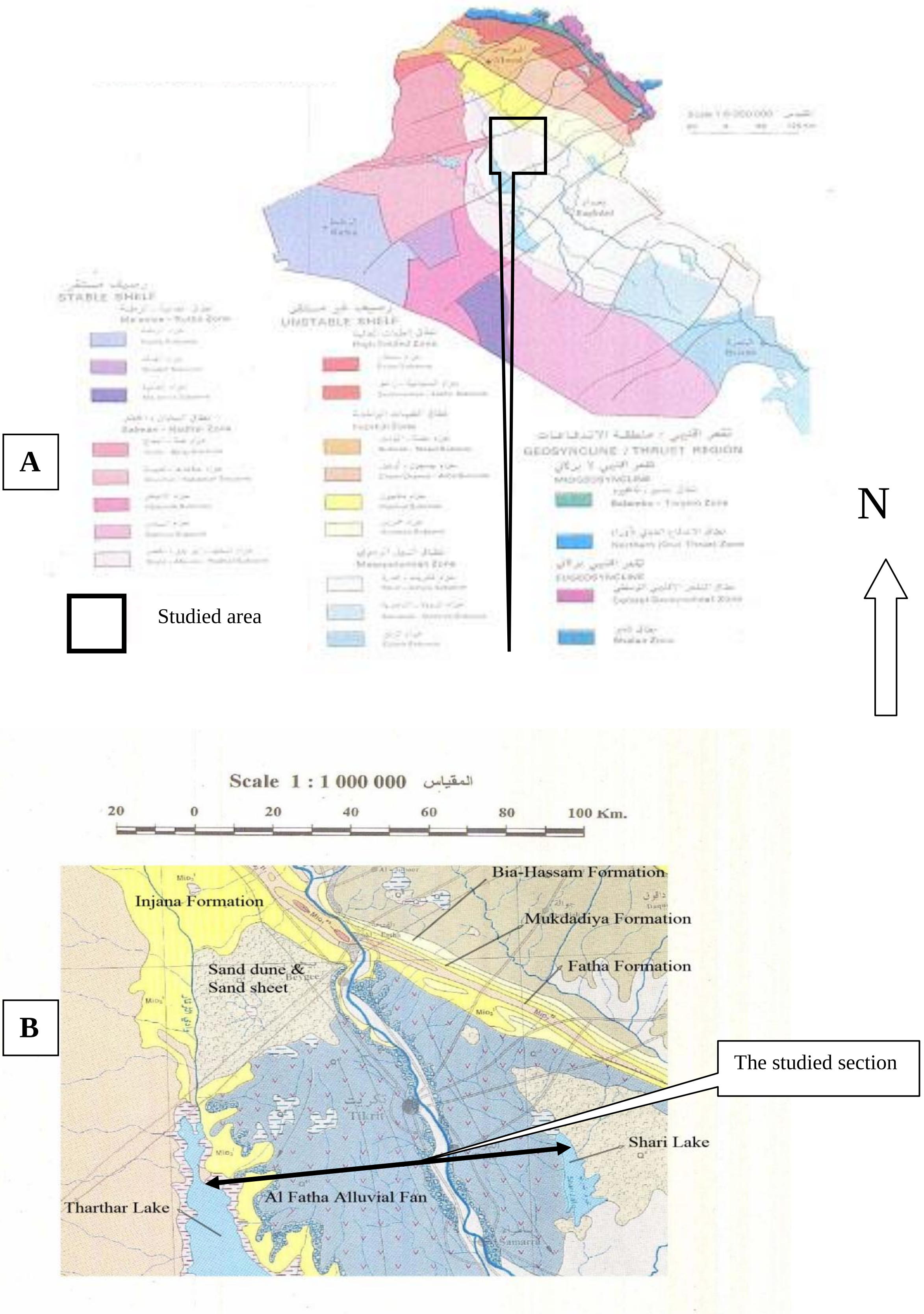

Figure 1: Location of the studied section: A) Location of the studied section and its surronding among tectonic division of Iraq, Al-Kadhimi et al. (1996), B) Surface geology of the area under veiw and the location of the studied section.

According to (op cit), the anticline within Tigris Sub Zone can be described as follows:

- Long anticline structures of relatively low amplitude and less expressive on or just below the surface
- Getting more expressive form depth wise.

Geologically, according to Jassim(1979), Al-Fatha alluvial fan covers the area between Baiji city in the north and Samarra city to the south including the studied section. Tour through domestic water wells (10-15 meter in depth) within the mentioned fan, including the studied section, clarifies that it consists from bottom to top:

- In some domestic water wells the Miocene or Pliocene sediments (Injana and Mukdadiya formations) are exposed at the base.
- (3- 12) meters thick, composed of igneous and sedimentary coarse sand, granule and, cobbles packed by sand and gypsiferous fine clastics as cementing material (Pleistocene).
- (0.5-3.0) meters of highly gypsiferous fine clastics, maximally reach 5.0 meters in some localities, followed by conglomerate of variable thickness (Holocene)
- The fan surface is covered by different size of scattered gravel.

Barwary and Slewa (1993) indicate, in addition to the mentioned fan, other relatively more recent units (Holocene). The flood plain deposit of Tigris river consists of fine clastics i.e. sand, silt and clay covered by gravel of different sizes of gravels, moreover slope sediment covers the relatively low angle slopes to the north of Samarra city, composed of mixture of different size gravel, sand, silt and clay. Valley and depression fill sediments occupy the relatively low relief area, composed of fine clastics with relatively low percent of gypsum. Eolian sand covers the area around Shari Lake.

-Previous Work

There are different opinions concerning the starting time of neotectonic activity in Iraq. Moreover some of the workers in this field disagree about the exact definition of neotectonics. There are few studies in Iraq concerning the broad title of the present paper i.e. neotectonics:

- Parsons (1957) observed differences in the thickness of young sediments of the alluvial plains of Mesopotamian Zone and confirmed that the Alpine movements became still but not stand still.
- Al-Sakini (1975) studied drainage patterns including the main rivers in Iraq and concluded that there is strong evidence of neotectonic activity evidenced by sharp variation of river courses.

- Buday and Jassim(1987) indicated that on the orginally none uplifted areas of foreland basins (including Mesopotamian Zone), the deposition of molasses was slower and their thickness was diminishing over the still rising mountain, and pointed out that the processes continued into Quaternary.
- According to 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. This may support the chosen boundary in the present work keeping in mind that each area has its own characters.
- Al-Janabi (1996) clarified that the Middle-Upper Miocene boundary, was considered by AEE (1985), as the starting point of neotectonic activities in Iraq and considered it to be a phase of tectonic stability regime depending on: Predominance of carbonates and halogen sediments in Oligocene and early M. Miocene sediments is an indication that the later was not much elevated above sea level and its heights were within some dozen meters relative to the present sea level. Moreover, within the beginning of Late Miocene the sedimentation condition changed abruptly. AEE, 1985 portrayed unpublished neotectonic map of Iraq scale 1:1000000.
- Sissakian and Deikran (1998) presented a published neotectonic map of Iraq, 1:1000000 on a scale, following the criteria mentioned by AEE (1985). According to the mentioned map the studied cross section, in this study, passes through areas of relative uplift and subsidence.
- Deikran (1998) studied five anticline structures that are in the Baiji-Samarra area (including the area of the studied cross section). He gave a lot of evidences supporting recent tectonic activity in the way of studying lineaments, delineating and calculating the intensity and rate of uplifts and subsidence and calculating the orientation of stresses.
- Yacoub et al. (1991) illustrate that there is a neotectonic activity in the area under view by means of deformed conglomerate on the top of Samarra structure, figure 2.

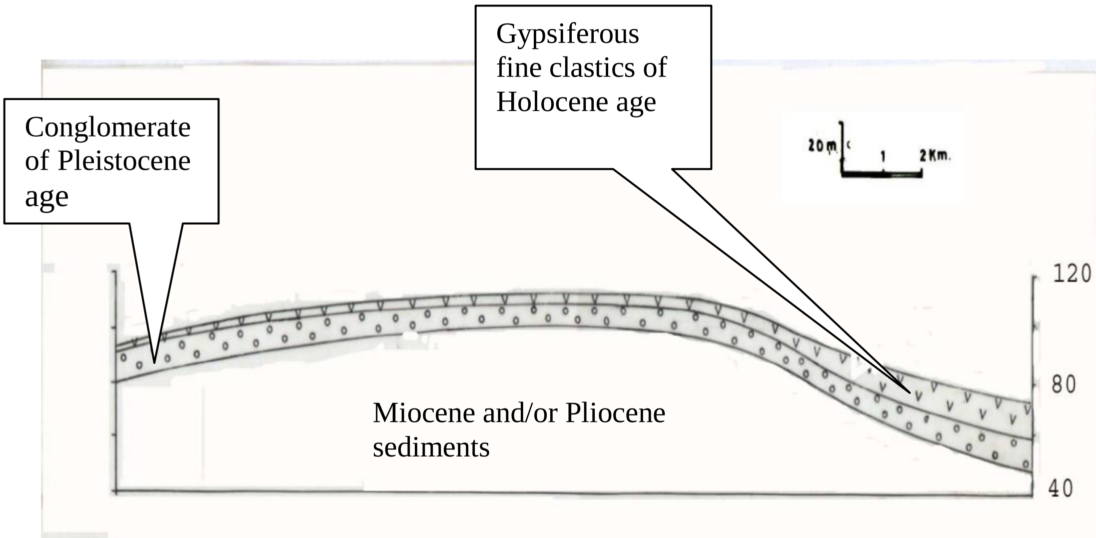

Fig. 2: Deformed conglomerate deposit of Pleistocene age in Samarra structure, from Yacoub et al. (1991)

In addition to aforementioned studies, the presence of abnormal Quaternary landforms, like topographic indications for subsurface anticline, abandoned channels, inactive and/or abandoned alluvial fans shifting of river course are all good indications for neotectonic activities. Such indications are confirmed by different authors, among them are (for example) (Cohen et al. 2005; Kumanan, 2001; Jones & Arzane, 2005; Markovic et al., 1996; Mello et al., 1999, Woldai & Dorjsuren, 2008 and Koster, 2005).

Method of study

It can be summarized in the following steps:

- Reviewing of previous works concerning the subject of the present paper.
- Collecting necessary working material such as: topographic maps to construct the topography and location map of the studied cross section, Surface geological maps to locate the structures, which meet the studied cross section. Subsurface boundaries from depth maps (Internal reports from INOC). Surface water data to fix surface water of Tharthar Lake.
- Extraction sea level and absolute age of the lower boundary of the subsurface boundary from Lindz and Bralower (1995). All the aforementioned data are grouped in three cross section, Figure 2 A, B and C.
- Delineation of subsidence and uplifts (intensity) by comparing the plotted boundaries with their sea level height.

- The rates of movements are calculated from specified boundary passing through geological time towards recent and as follow:
  Rate of movement=intensity of movement/ Time
- Interpretation the type of neotectonic structures and writing the present paper.

Calculations and assumptions

Deformation can be detected only if the original form of a unit or topography is well established, Vita Finzi, 1986. In the present study the original form (undeformed) of the studied stratigraphic boundary are represented by sea level in the time of deposition relative to the present sea level. Any deviation in the selected Early-Late Miocene, Late Miocene-Pliocene and Pliocene-Pleistocene boundaries from their associated sea level should be fixed. The deviation is expressed as uplift when the selected boundary is located above the associated sea level and subsidence when the selected boundary is located beneath the associated sea level. Moreover, the contemporary topography is involved in this comparison. In our assumption, the detected uplift and subsidence are caused by tectonic movements. The rate of the uplift is usually calculated by dividing the intensity (amplitude) of uplift in meters over the absolute age in years. The absolute age represents the whole time starting from Pliocene-Pleistocene boundary (for instant) to the present time. The absolute age and height of sea levels of the selected boundaries according to Van Easinga (1975) and Lindz and Bralower (1995), respectively are as follow, table 1 :

Table 1: Height of sea level of the studied boundaries

Boundary	Absolute age	Height of sea level
Pliocene-Pleistocene	1.9 Ma.	-125
U.Miocene –Pliocene	5.3 Ma.	25
M.U. Miocene	10.4 Ma.	-50

Types of neotectonic structure are simply classified in to inherited and uninherited topographic features depending on the (Mescherikov, 1959).

Case Study

It includes the relation among: the contemporary topography, the subsurface contact of the selected boundaries of different ages and their associated heights of sea levels. Figure 3 A, B, and C shows that Shari Lake can be classified as inherited feature because the shape of its contemporary topography comes in accordance with the nature of the Early-Late Miocene boundary beside, the later boundary is located beneath its associated sea level. Simply this means that the area of Shari Lake had continuous subsidence at least from the Early-Late Miocene boundary. The calculated intensity of subsidence (940 m.) is roughly equal to that calculated by Sissakian and Deikran, 1998 (1000 m.) and the rate of movement is 0.0903 mm. / year, see table 2. The case is the same in Miocene/Pliocene. This boundary still accords with contemporary topography and it is located beneath sea level. Thus Shari Lake can be classified as inherited feature, in this stage, and subsidence is still continuing, see figure 3B. The intensity and rate of the subsidence is 115 m. and 0.0216 mm. / year. The Pliocene/Pleistocene boundary, figure 3C, does not extend over the whole area of cross section including Shari Lake. The lack of continuous conglomerate bed does not permit to detect type of neotectonic movements. Accordingly, Shari Lake indicates continuous subsidence during Late Miocene and Pliocene. Most probably at the beginning of Pleistocene uplift was prevailing as it is a part of the whole area followed by subsidence which is continued toward recent time.

The topographic expression of Samarra (anticline like structure) seems to be inherited from old structure because the shape of contact of Early-Late Miocene has, more or less, the same configuration as for contemporary topography i.e. differential uplift, although it shows subsidence (in general), figure 3 A. The intensity of subsidence is 290 m. and the rate of movement is 0.0278 mm. / year respectively, see table 2. The case is the same for Early-Late Miocene-Pliocene boundary, thus it is considered to be inherited from old structure although the area in this stage suffers subsidence, figure 3 B. The intensity and rate of subsidence is 30m. and 0.0056 mm. / year, respectively, see table 2. The Pliocene-Pleistocene boundary is located above the associated sea level at the area where Samarra topographic expression exists and it is in accord with the contemporary topography; consequently it reveals continuous uplift during Pleistocene and most probably in the Holocene, figure 3C. This is supported also by Pleistocene conglomerate deformation figure 2. The intensity is calculated to be 100 m. and the rate of movement is 0.00521 m. / year, see table 2.

The topographic expression of Salahaldeen (dome or anticline like structure) has no relation to Early-Late Miocene boundary and thus it can be classified as super imposed neotectonic surface feature although it shows subsidence in this stage. The intensity and rate of subsidence is 185 m. and 0.0177 m. / year, respectively, see table 2. The subsurface boundary of Late Miocene –Pliocene beneath Salahaldeen structure dips toward E and there is no indication of folding in this boundary and it is above its sea level , consequently there is no indication for accordance with surface expression .Thus, it is uninherited feature?. The intensity and rate of uplift is 25 m. and 0.0047 mm. / year, respectively see table 2. Salahaldeen and Samarra features are similar in neotectonic characters during Pleistocene age and also in Holocene. The intensity and rate of uplift in Salahaldeen topographic expression is 120 mm. and 0.0631 mm. / year, respectively see table 2. Tharthar Lake is a good example of superimposed neotectonic structure. It has no relation to Early-Late Miocene boundary configuration as shown in figure 3A. It is located at the beginning of the uplift. The lake shows uplift during Late Miocene, Pliocene and Early Pleistocene time, figure 3B and C. A differential subsidence probably occurred Post Early Pleistocene age and continued in Holocene.

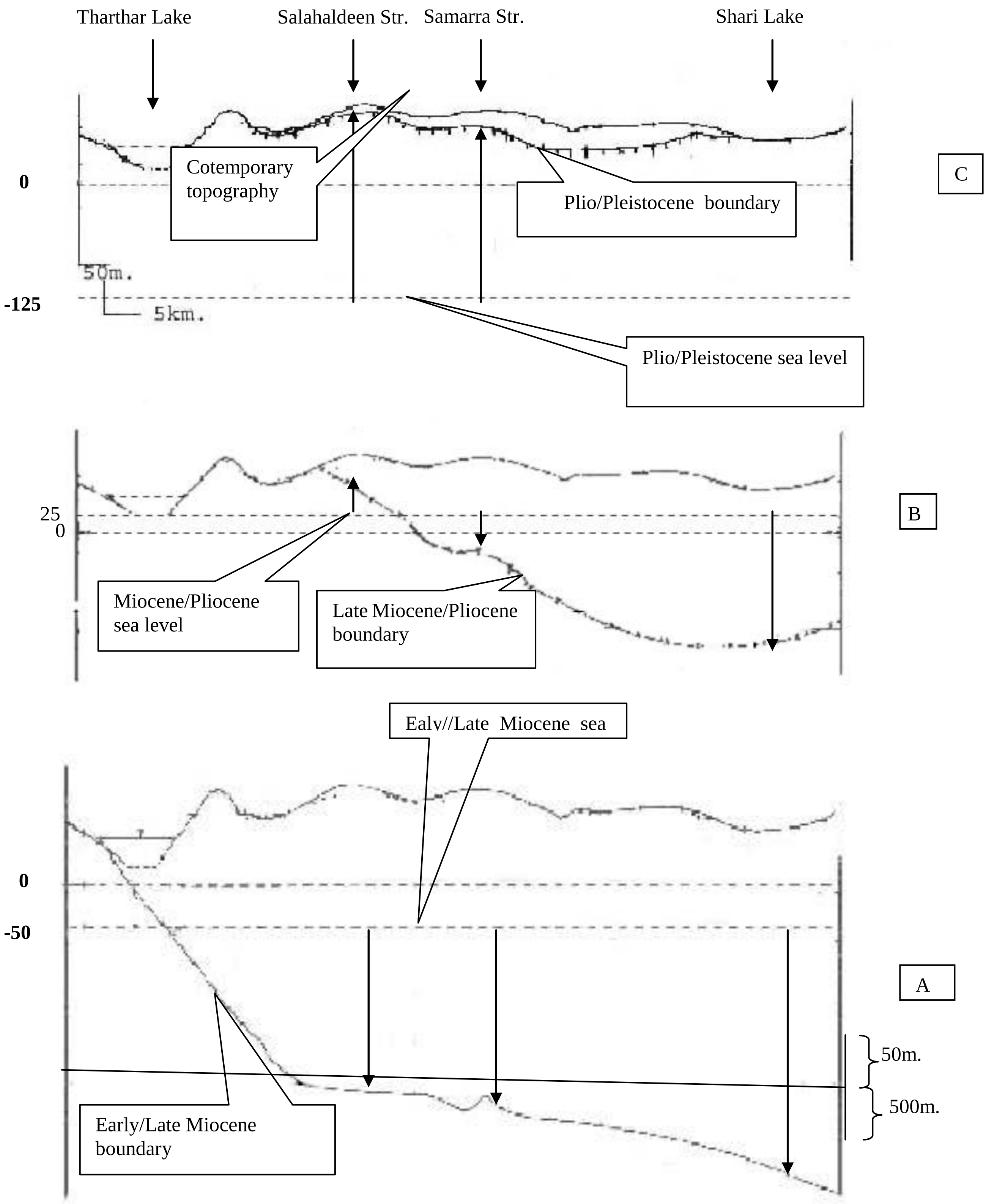

Fig. 3: Cross section shows the relation of topography to different stratigraphic boundaries and contemporary topography, Data from: Topographic map scale 1:100000, Inoc,(Internal report, Lindz; Bralower, 1995).

	Shari Lake	**Samarra**	**Salahaldeen**	**Tharthar Lake**
M.U. Miocene -Relation of U./M. Miocen contemporary topography -Type of movement -Intensity(m.)/ Rate of mov	 Concordant Subsidence 940/0.0903	 Concordant Subsidence 290/0.0278	 Discordant Subsidence 185/0.0177	 Concordant Subsidence 25/0.0024
U. Miocene/Pliocene -Relation of U. Miocene/Pl contemporary topography -Type of movement -Intensity(m.) / Rate of movement(mm./y)	 Concordant Subsidence 115/0.0216	 Concordant Subsidence 30/0.0056	 Concordant Uplift 25/0.0047	 Discordant Uplift ?
U. Pliocene/Pleistocene -Relation of Pliocene/Pleis contemporary topography -Type of movement -Intensity(m.) / Rate of movement(mm./y)	 ? ? ?	 Concordant Uplift 100/0.0052	 Concordant Uplift 120/0.0631	 ? Uplift-subs. ?

Table 2: The summary of result

Conclusion

-Type, intensity and rate of movement of the studied surface expression are assisted.

-Shari Lake is an inherited surface expression showing continuous subsidence from post M. Miocene and Pliocene. In Early Pleistocene the whole area was uplifted including Shari Lake, then subsidence continued till the recent time as indicated by surface expression.

-Samarra topographic expression is an inherited expression (suffering differential uplift) during: U. Miocene, Pliocene, and Pleistocene and during the recent time although the surrounding area shows subsidence.

-Salahaldeen topographic expression is superimposed neotectonic expression during U. Miocene and Pliocene and inherited expression during Pleistocene and Holocene.

-Tharthar Lake is superimposed neotectonic surface expression .It suffered uplift in U. Miocene, Pliocene and Early Pleistocene. The differential subsidence occurs from Early Pleistocene till recent time and still continues.

-As it is well known, the migration of Late Alpine Orogeny to Pleistocene was confirmed in many localities by this study.

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بعض الملاحظات النيوتكتونية لمظاهر طوبوغرافية مختارة بين بحيرتي الشاري والثرثار وسط العراق

دريد بهجت ديكران
كلية العلوم ــ جامعة كركوك

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الخلاصة

تهدف الدراسة توضيح نوع و شدة ومعدل الحركات الأرضية لتراكيب تحت سطحية معكوسة على سطح الأرض بطريقة تقييم البيانات السطحية و تحت السطحية وبواسطة ثلاث مقاطع جيولوجية في وسط العراق. وتم التوصل الى هذا بمقارنة الحدود المختارة ضمن فترة الزمن النيوتكتوني مع ارتفاعاتها الأصلية والممثلة بأرتفاعات مستوى سطح بحرها مع الطوبوغرافيا الحالية. ان سطوح البحر المختارة قد افترضت ان تكون الحالة الأصيلة للحدود الفاصلة. ان الدراسة الحالية افترضت اي حيود عن السطح البحر الفريد ممكن ان يكون بسبب حركات عمودية (صعود او هبوط).

تم دراسة اربعة اشكال (تراكيب) ارضية معكوسة على السطح وضمن ثلاثة مقاطع عرضية، كل منها لها حدود ستراتغرافية خاصة ومستوى سطح بحر معين. هذه الأشكال الأرضية هي: تراكيب سامراء و صلاح الدين بالأضافة الى بحيرتي الشاري و الثرثار، بالأضافة الى ان المقاطع تتضمن: الطوبوغرافيا الحالية، والحدود الفاصلة بين المايوسين المتوسط والمتقدم المايوسين المتأخر والبلايوسين واالبلايوسين والبلاستوسين. تم اختيارا هذه الحدود من الخرائط الجيوفيزيائية العمقية مع ارتفاعات بحارها من مصادر اخرى. ان الأرتفاع الأول يمثل طور تكتوني مستقرولكن الأثنان الآخرين لا يمثلانه ولاكنهما ادخلا في الدراسة الحالية للتوضيح وليكون القارى على اطلاع للأحداث النيوتكتونية.