# GIS in an Overview of Iraq Petroleum Geology

By
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## General Comments

Georeferenced maps of Iraq, almost entirely from AAPG publications, are presented herein to show the overall framework of this country within a region that contains vast petroleum resources and to show some features of representative fields. Several maps of fields are accompanied by cross-sections; correlation diagrams for Northern and Southern Iraq are presented along with a tabulation of the various producing stratigraphic units. For presentation, each map utilizes the geographic coordinate system wherein each increment of latitude and longitude is equal.*

An additional item that is presented in this preliminary compilation is a database of giant fields in Iraq, from the comprehensive databases of giant fields compiled by M.K. Horn to be incorporated in the soon-to-be-published AAPG Memoir, Giant Oil and Gas Fields of the Decade 1990-1999.

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*Maps presented herein are available in ARCview, from AAPG online bookstore (http://bookstore.aapg.org). They are accompanied by the other illustrations (in PDF format), with appropriate links.

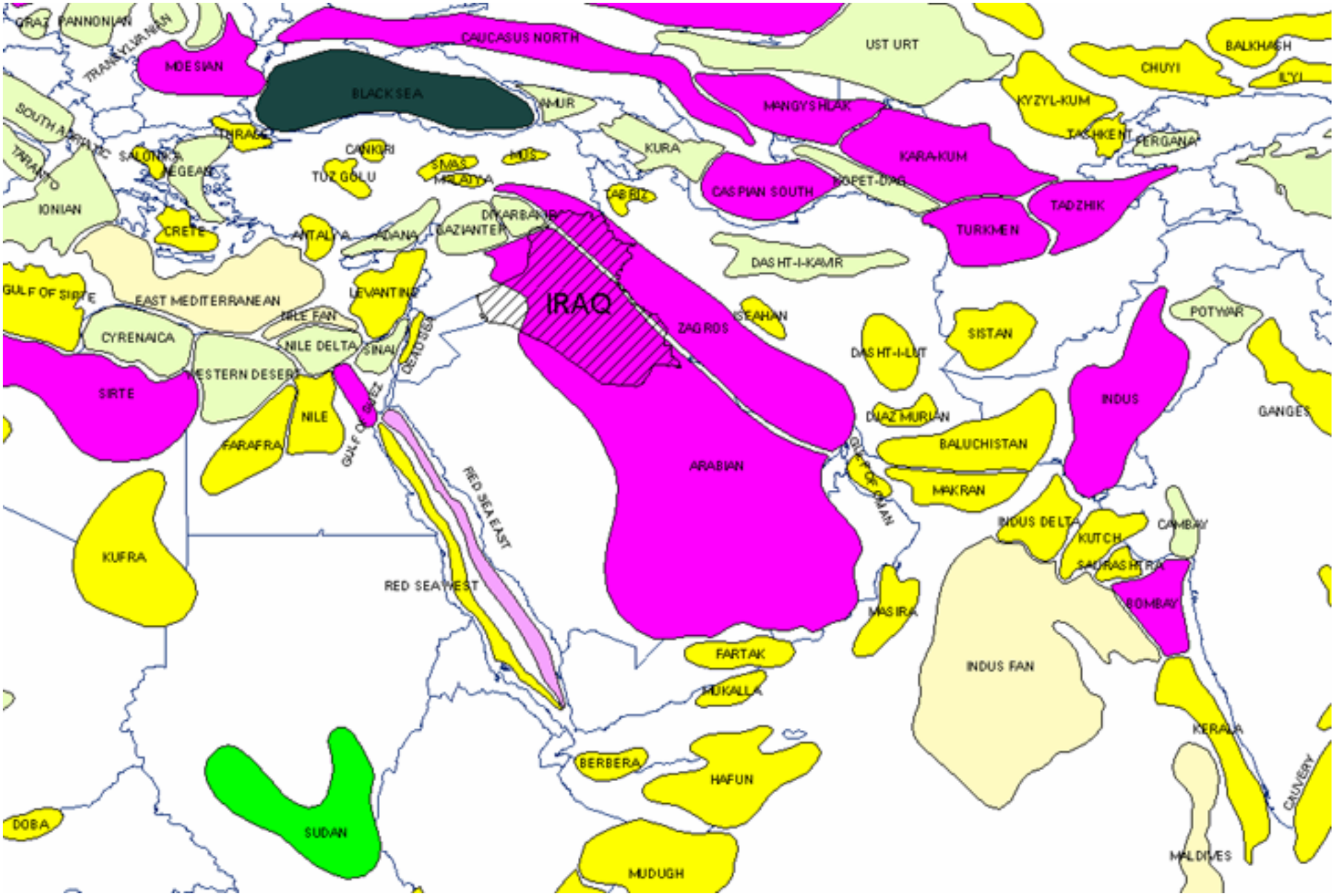



**Figure 1. Sedimentary provinces of much of Europe, Africa, and Asia, centered on the Zagros (a folded belt) and Arabian (foredeep) provinces (from St. John et al., 1984).**

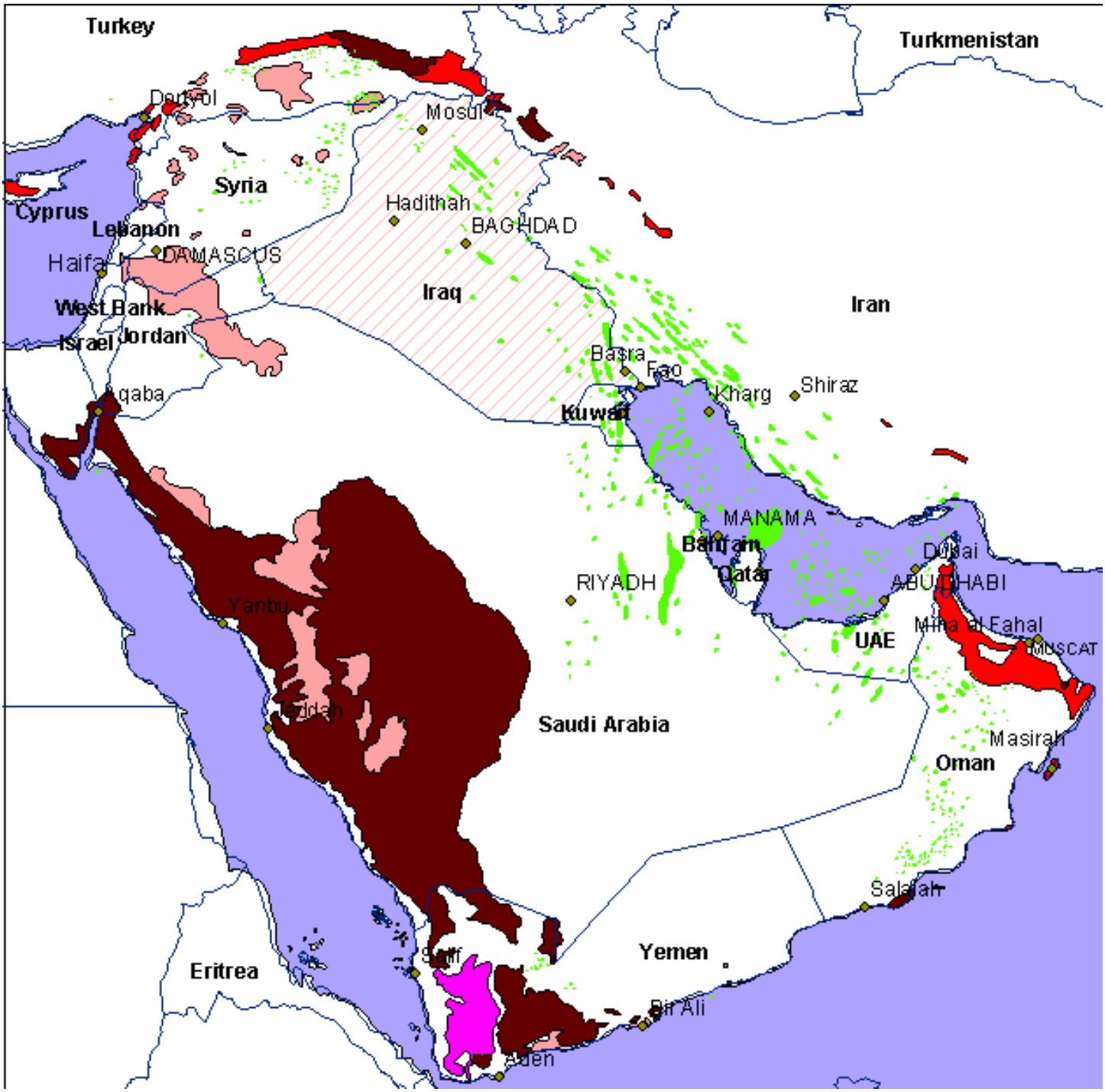
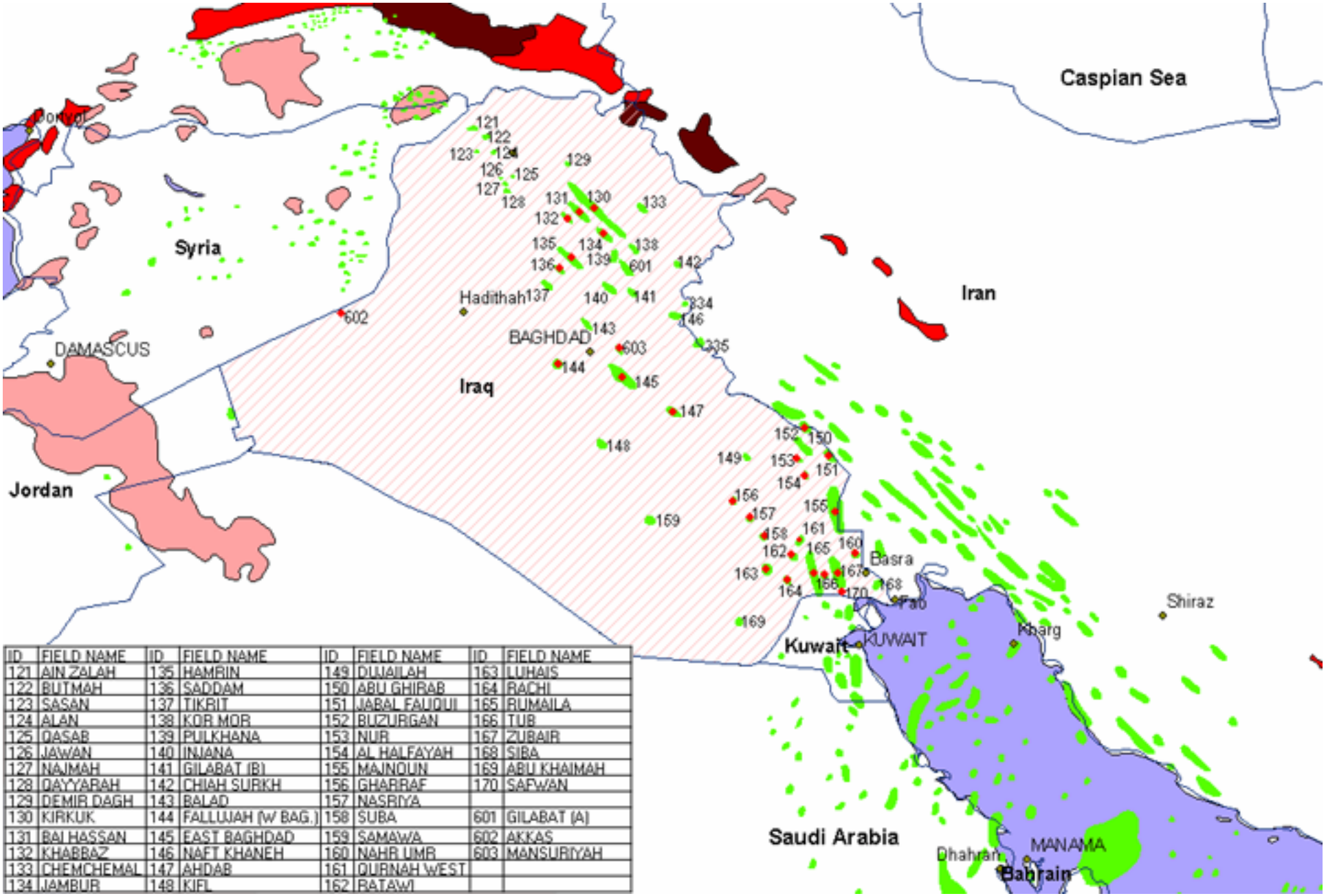



**Figure 2. Fields and discoveries (as of 1990) of the Arabian Plate (from Beydoun, 1991). Precambrian rocks in brown, Cretaceous ophiolites, etc. in red, Cretaceous-Quaternary volcanics in two shades of pink.**




| ID | FIELD NAME | ID | FIELD NAME | ID | FIELD NAME | ID | FIELD NAME |
|---|---|---|---|---|---|---|---|
| 121 | AIN ZALAH | 135 | HAMRIN | 149 | DUJAILAH | 163 | LUHAIS |
| 122 | BUTMAH | 136 | SADDAM | 150 | ABU GHIRAB | 164 | RACHI |
| 123 | SASAN | 137 | TIKRIT | 151 | JABAL FAUQUI | 165 | RUMAILA |
| 124 | ALAN | 138 | KOR MOR | 152 | BUZURGAN | 166 | TUB |
| 125 | QASAB | 139 | PULKHANA | 153 | NUR | 167 | ZUBAIR |
| 126 | JAWAN | 140 | INJANA | 154 | AL HALFAYAH | 168 | SIBA |
| 127 | NAJMAH | 141 | GILABAT (B) | 155 | MAJNOUN | 169 | ABU KHAIMAH |
| 128 | QAYYARAH | 142 | CHIAH SURKH | 156 | GHARRAF | 170 | SAFWAN |
| 129 | DEMIR DAGH | 143 | BALAD | 157 | NASRIYA | | |
| 130 | KIRKUK | 144 | FALLUJAH (W BAG.) | 158 | SUBA | 601 | GILABAT (A) |
| 131 | BAI HASSAN | 145 | EAST BAGHDAD | 159 | SAMAWA | 602 | AKKAS |
| 132 | KHABBAZ | 146 | NAFT KHANEH | 160 | NAHR UMR | 603 | MANSURIYAH |
| 133 | CHEMCHEMAL | 147 | AHDAB | 161 | QURNAH WEST | | |
| 134 | JAMBUR | 148 | KIFL | 162 | RATAWI | | |

**Figure 3. Enlargement of Figure 2, showing fields in Iraq, with tabulation of their names (from Beydoun, 1991). Fields with dots are Iraqi giant fields (from Horn, 2003).**

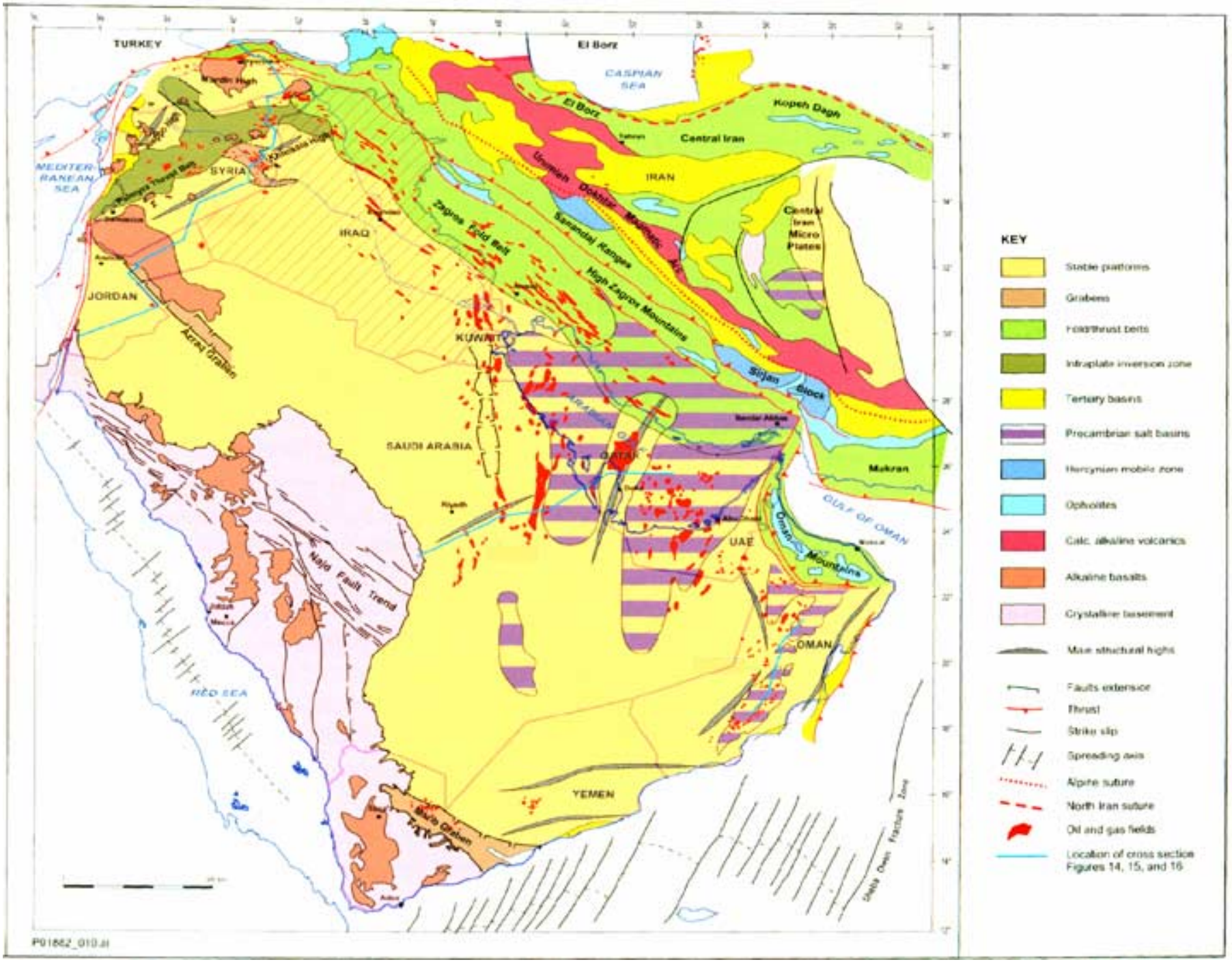



**Figure 4. Tectonic elements of the Arabian Plate and Iran (from Konert et al., 2001).**

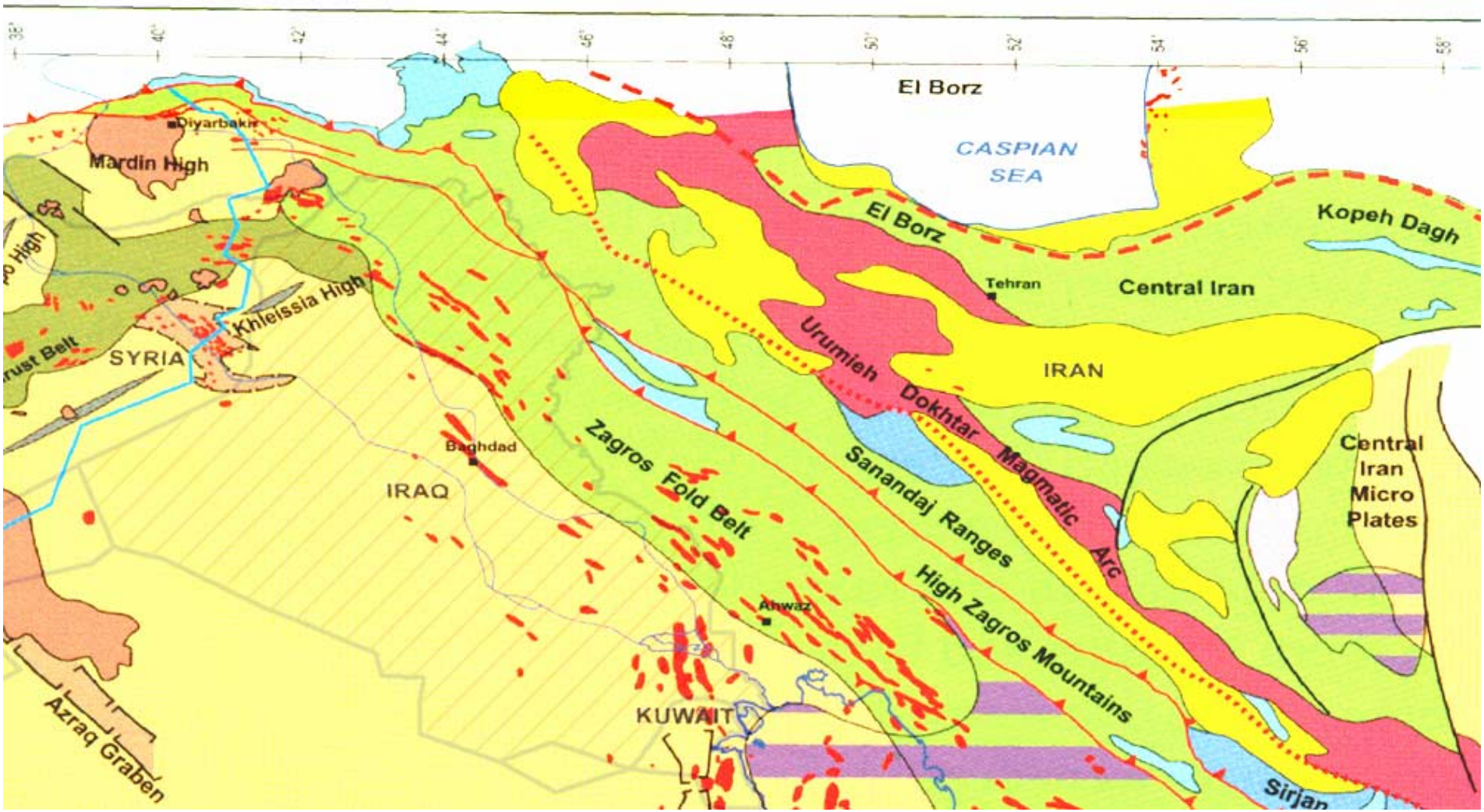



**Figure 5. Enlargement of Figure 4, showing tectonic elements of Iraq (from Konert et al., 2001).**

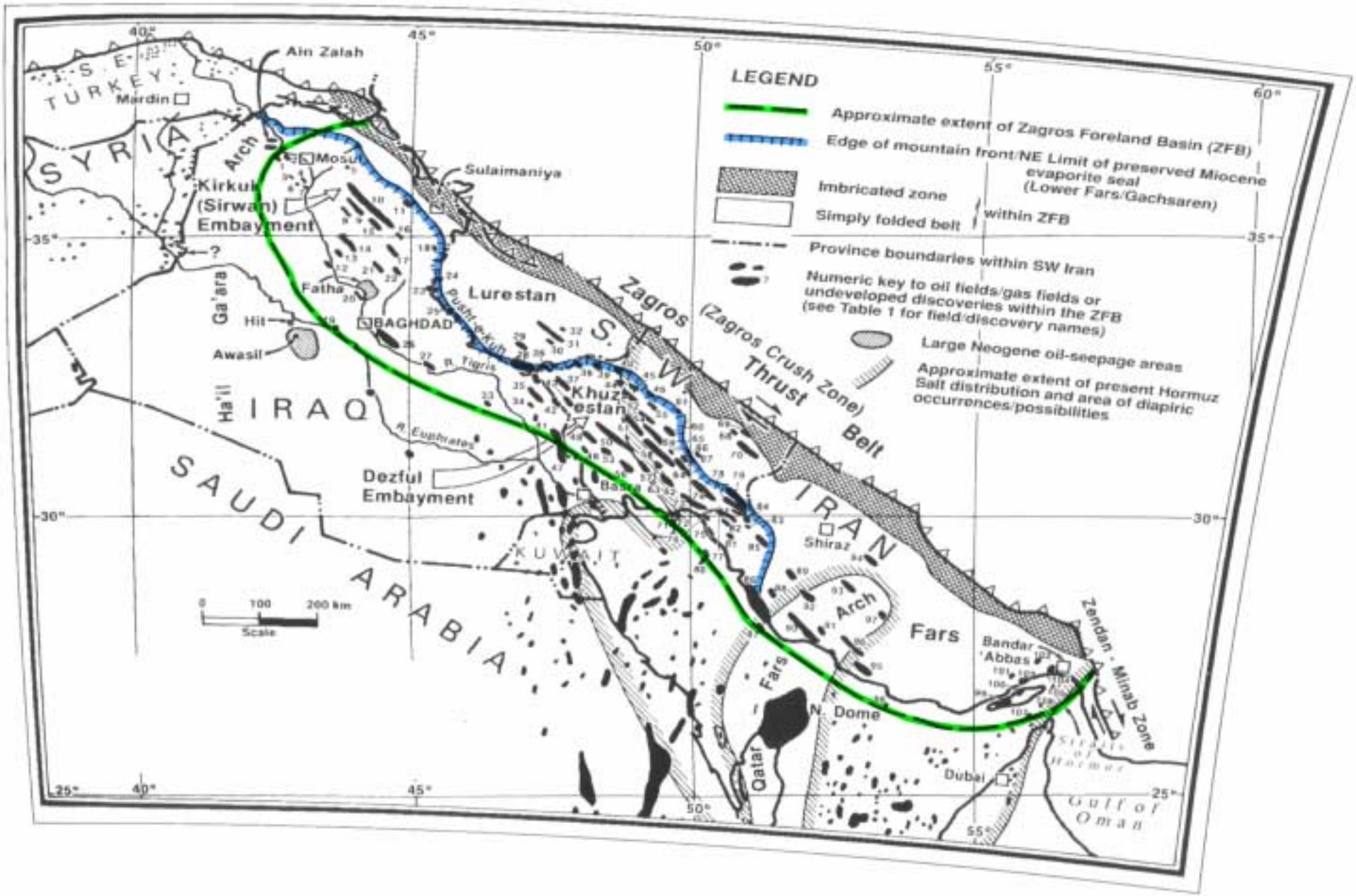



**Figure 6. Key structural elements in the Zagros province, with oil and gas fields (from Versfelt, 2001).**

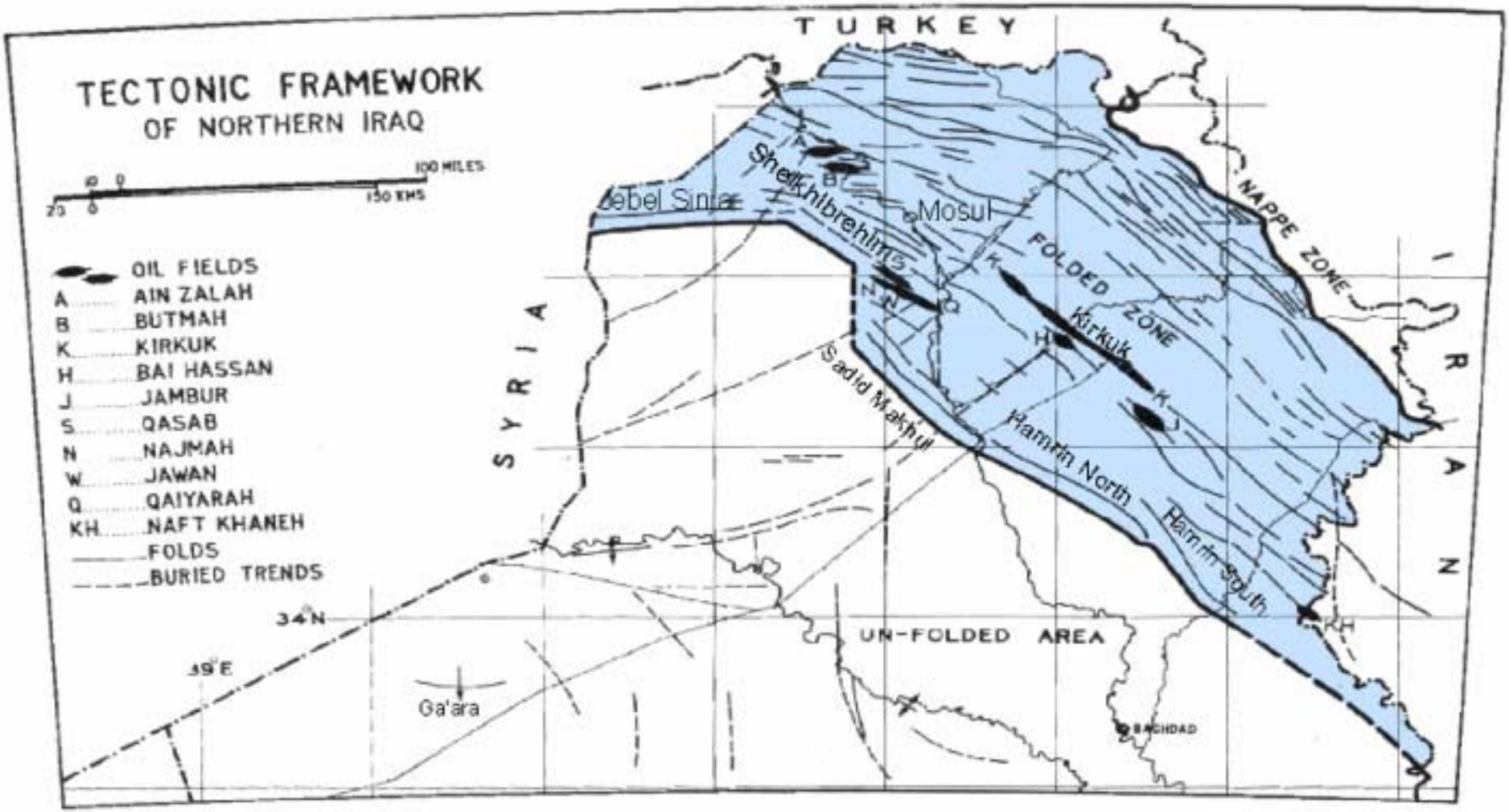



**Figure 7. Tectonic framework of Northern Iraq, with location of oil fields (after Dunnington, 1958).**

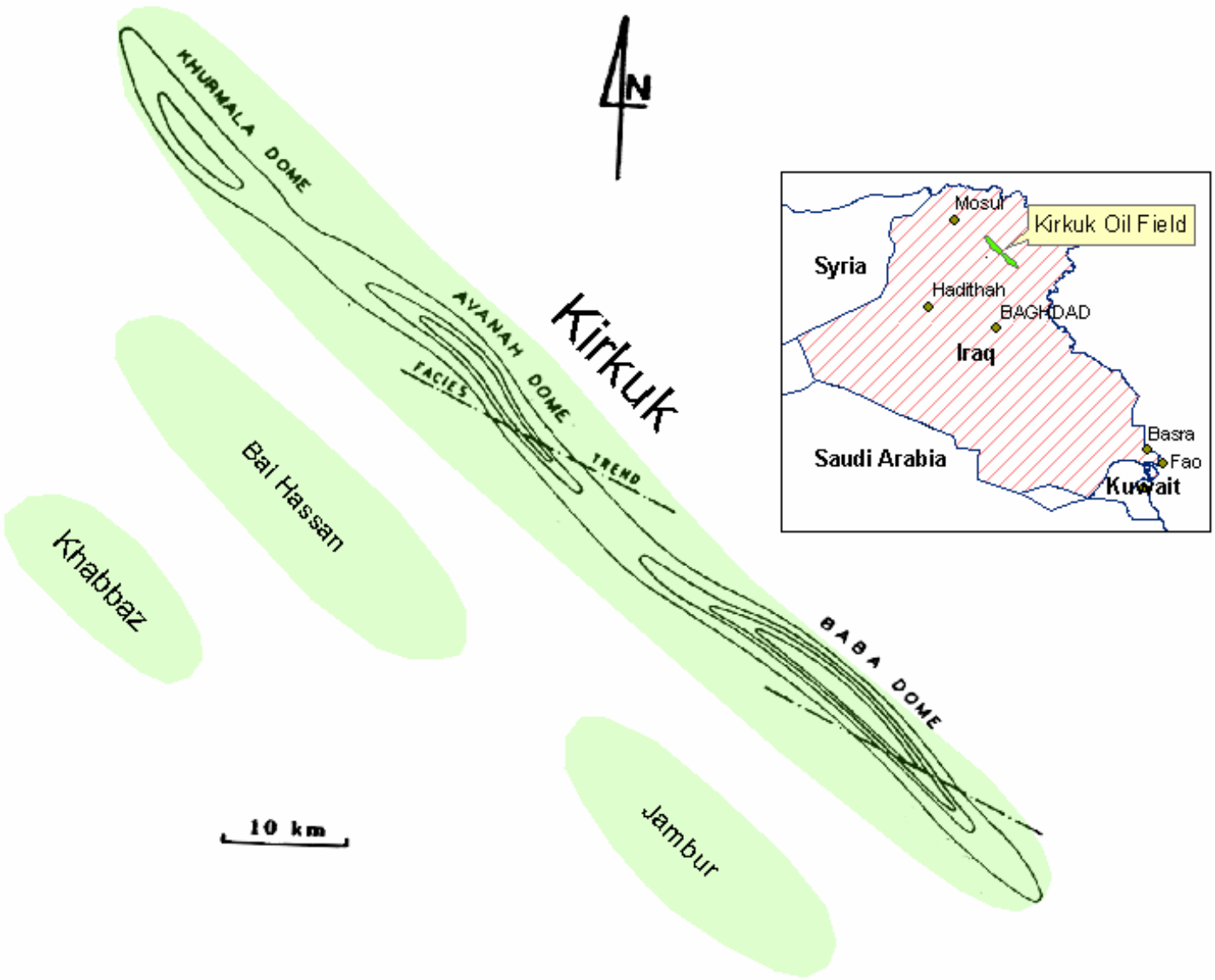



**Figure 8. Structural sketch map of Kirkuk field, Northern Iraq (after Dunnington, 1958; Majid and Veizer, 1986).**

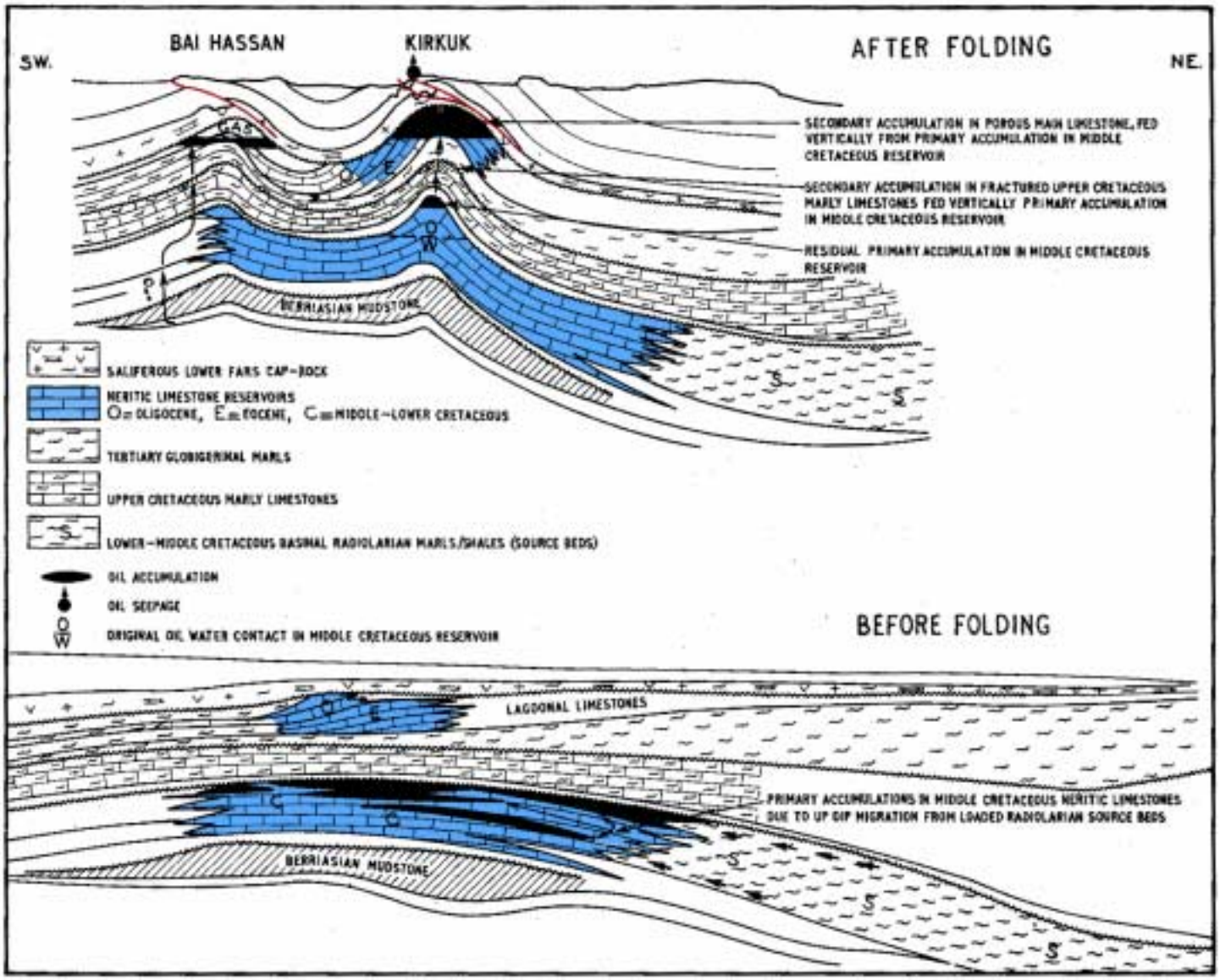



**Figure 9. Schematic cross-sections of Kirkuk area, illustrating accumulations in Baba dome and Bai Hassan field (after Dunnington, 1958). Click to view sequence of cross sections.**

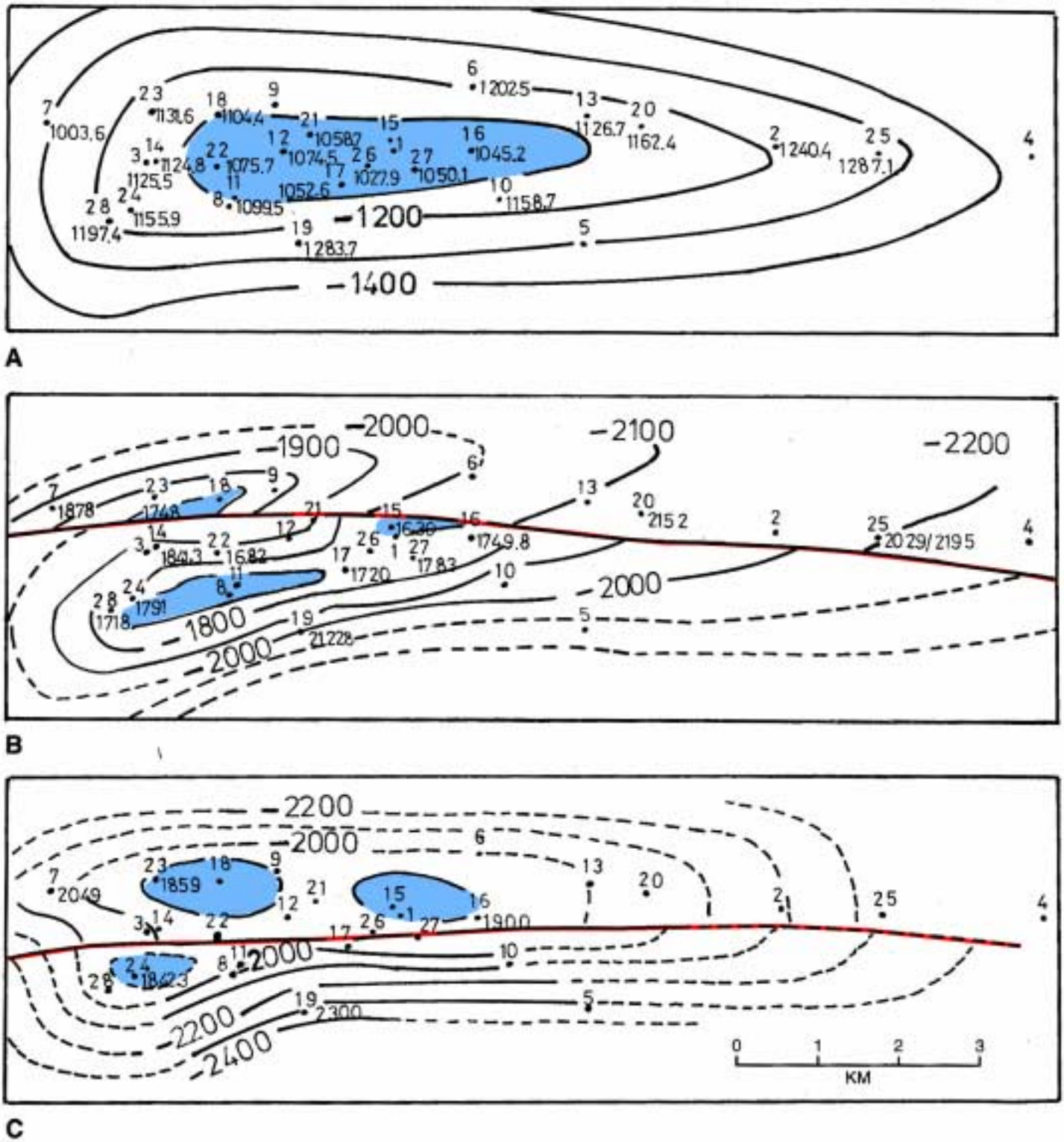



**Figure 10. Structure maps, Ain Zalah (from El Zarka 1993). A on top of upper Upper Cretaceous Shiranish Formation. B on top of Upper Cretaceouos Mashurah Formation. C on top of Lower Cretaceous Qamchuqa Formation. Click to view sequence of structure maps.**

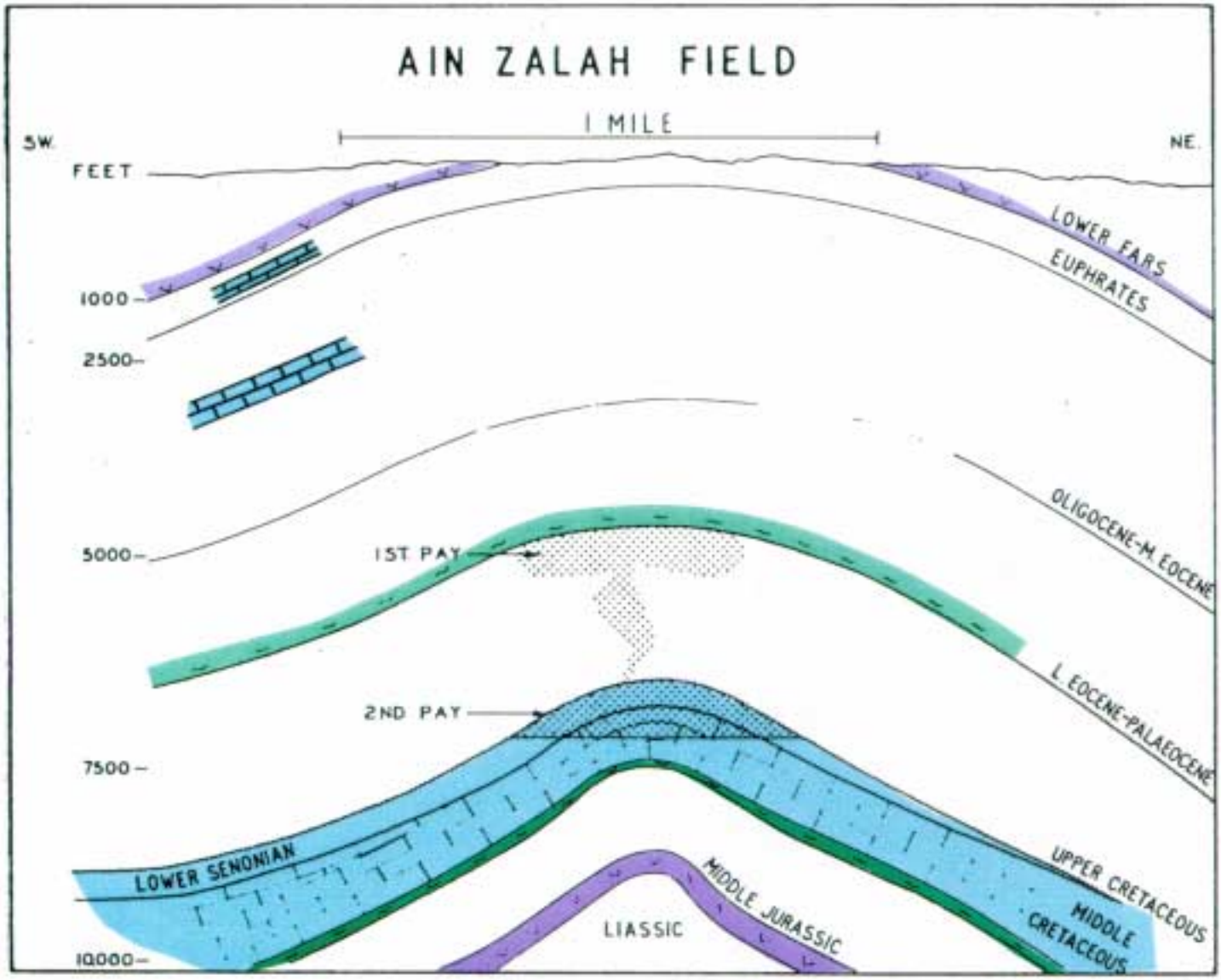



**Figure 11. Cross section of Ain Zalah field (after Dunnington, 1958).**

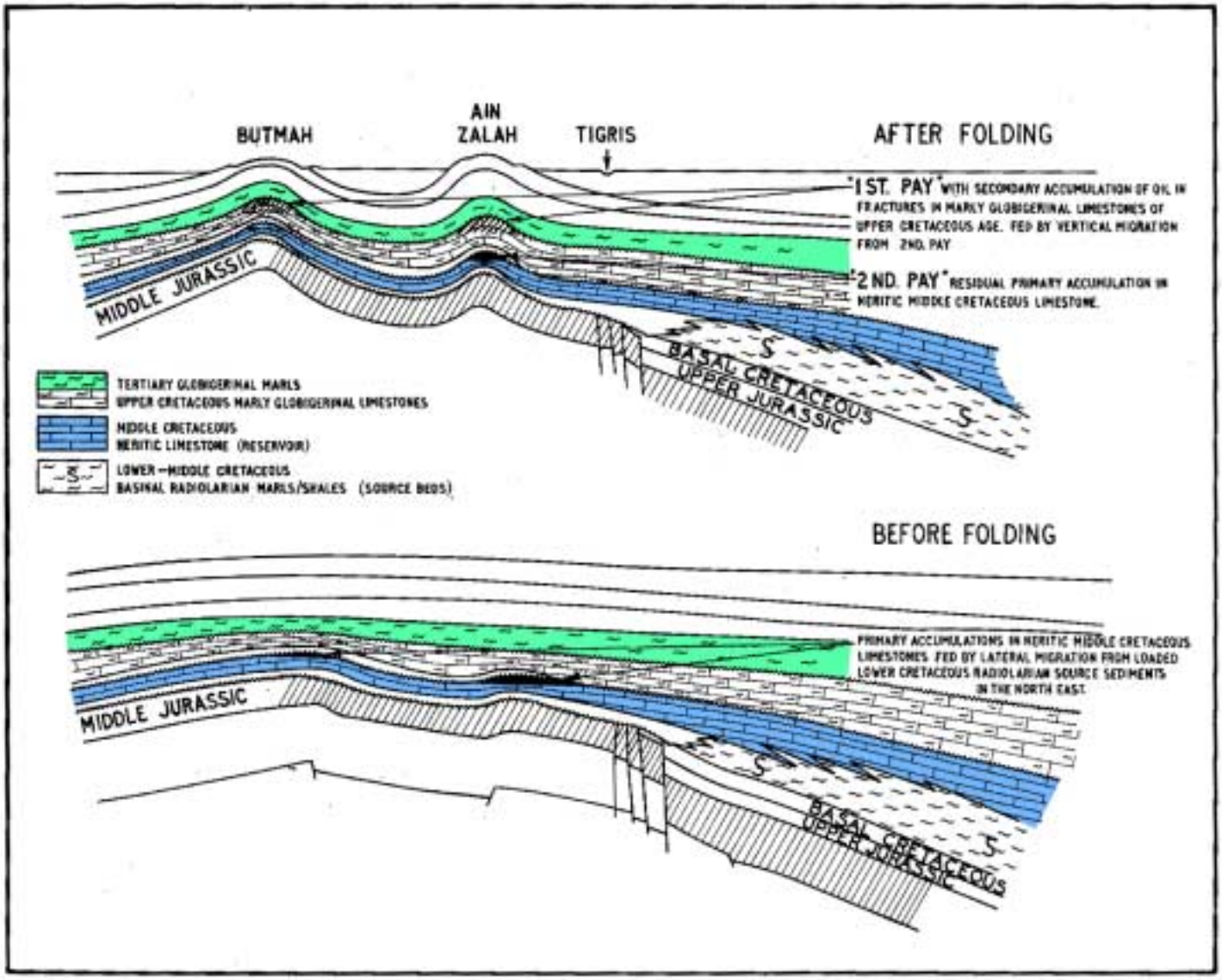



**Figure 12. Schematic cross-sections of Ain Zalah area, showing the entrapment of oil in Ain Zalah and Butmah fields (after Dunnington, 1958). Click to view sequence of cross sections.**

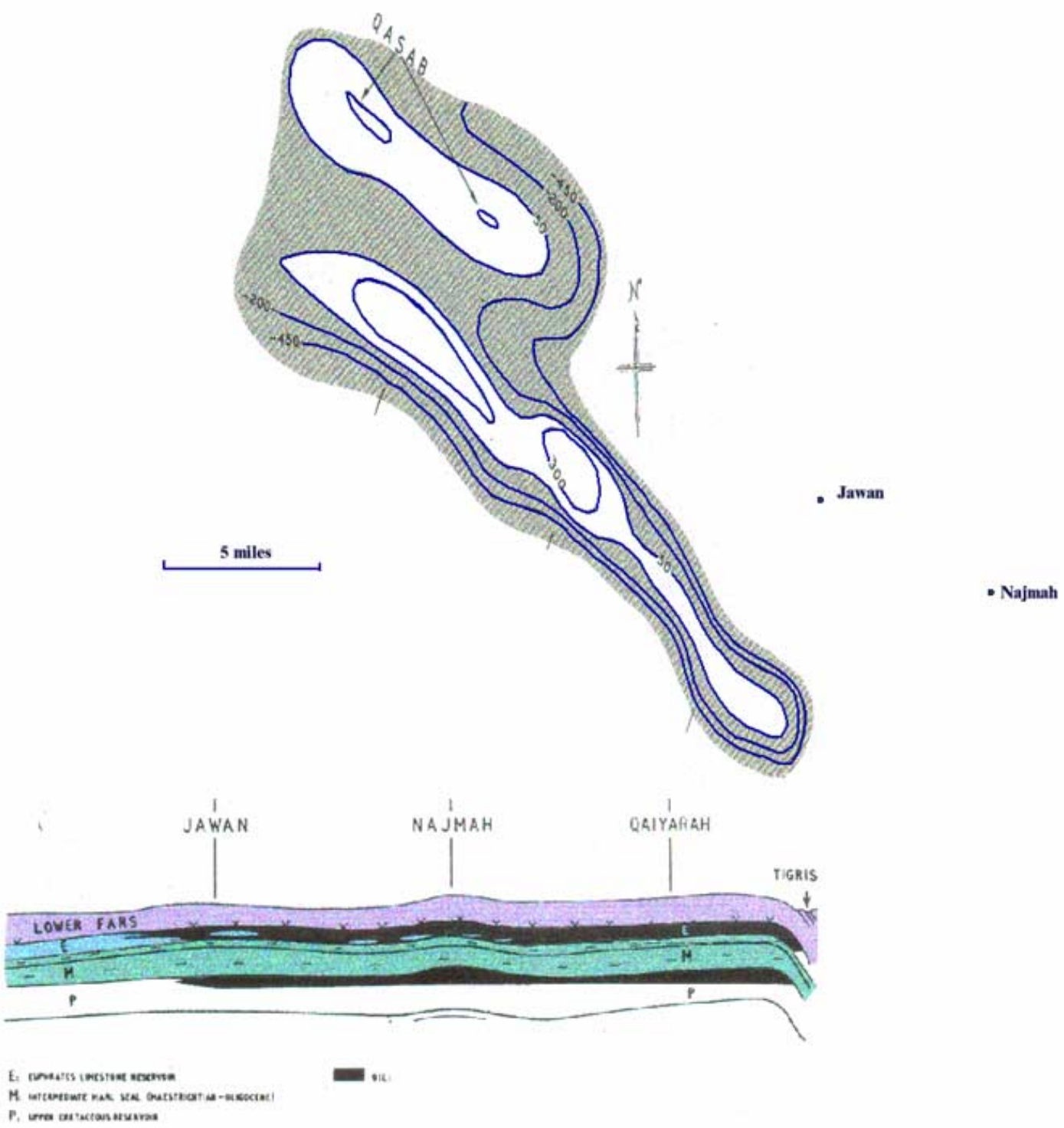



**Figure 13. Schematic structural map and cross section of fields in the Qaiyarah area, showing two superposed accumulations. Both show tilted oil-water contacts. (After Dunnington, 1958).**

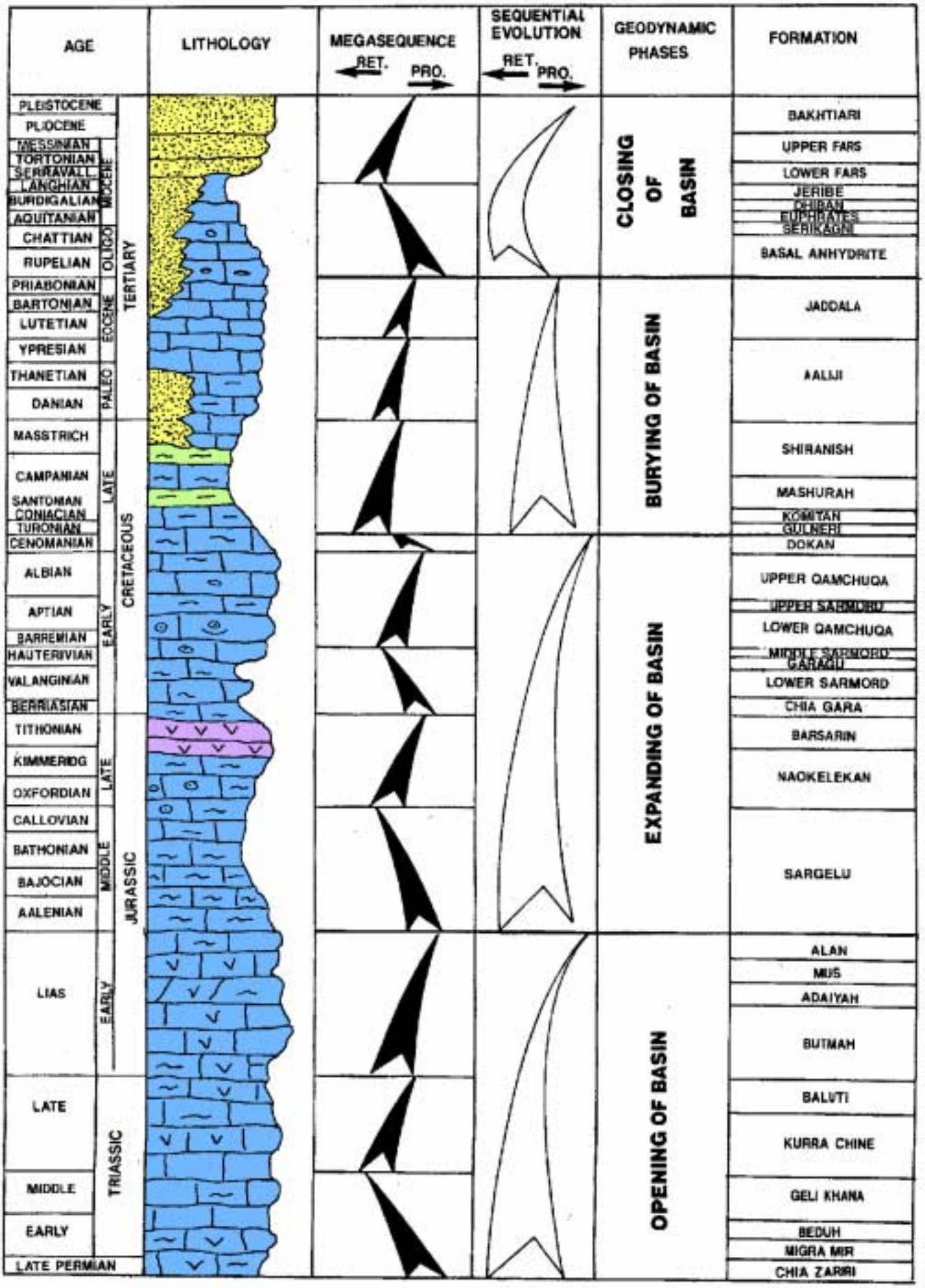



**Figure 14. Stratigraphic column, Permian-Pleistocene, Northern Iraq (after Al Shdidi et al., 1995).**

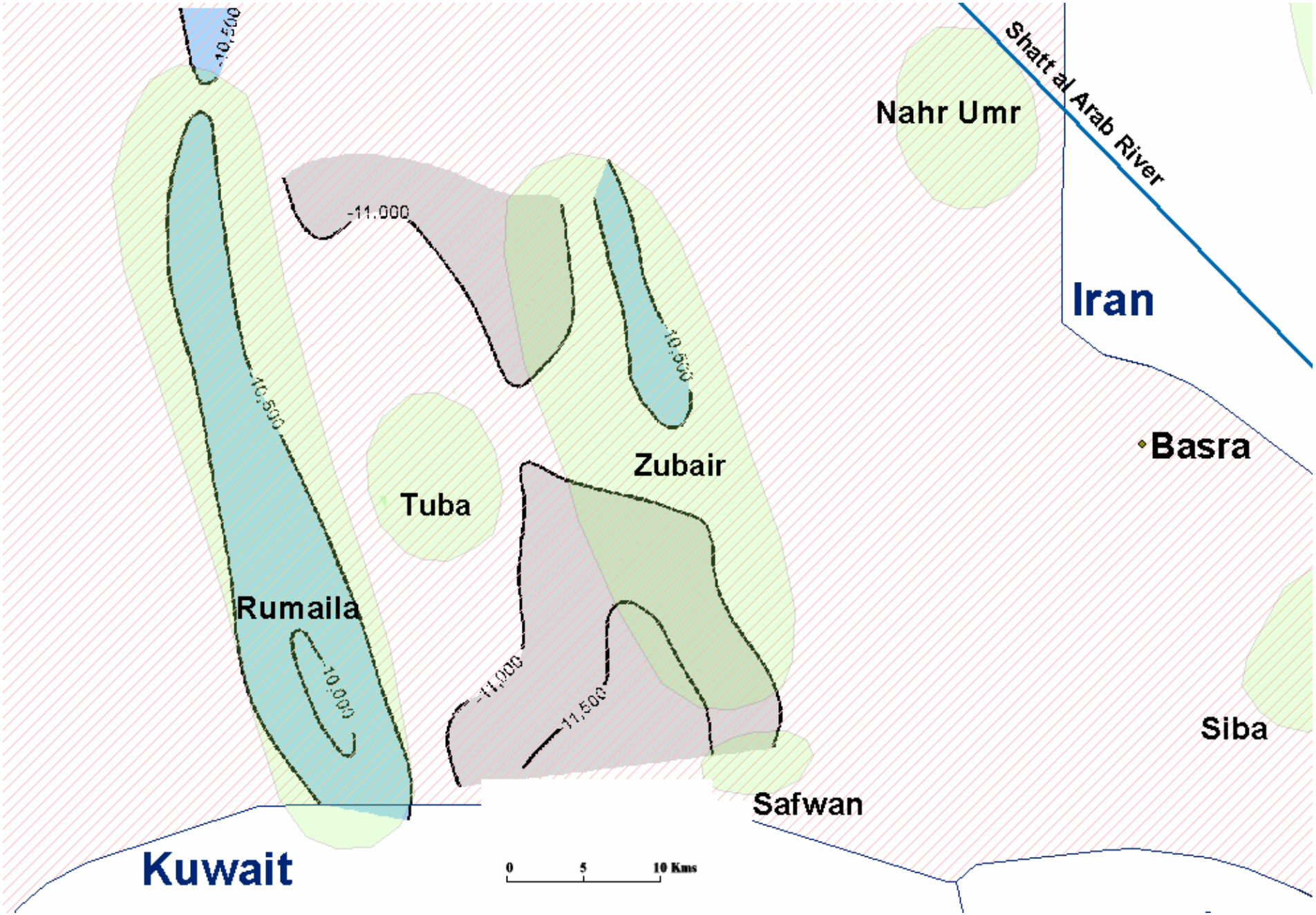



**Figure 15. Schematic structure map of Rumaila, Tuba, and Zubair fields, Southern Iraq, on Lower Cretaceous Zubair sandstone.**

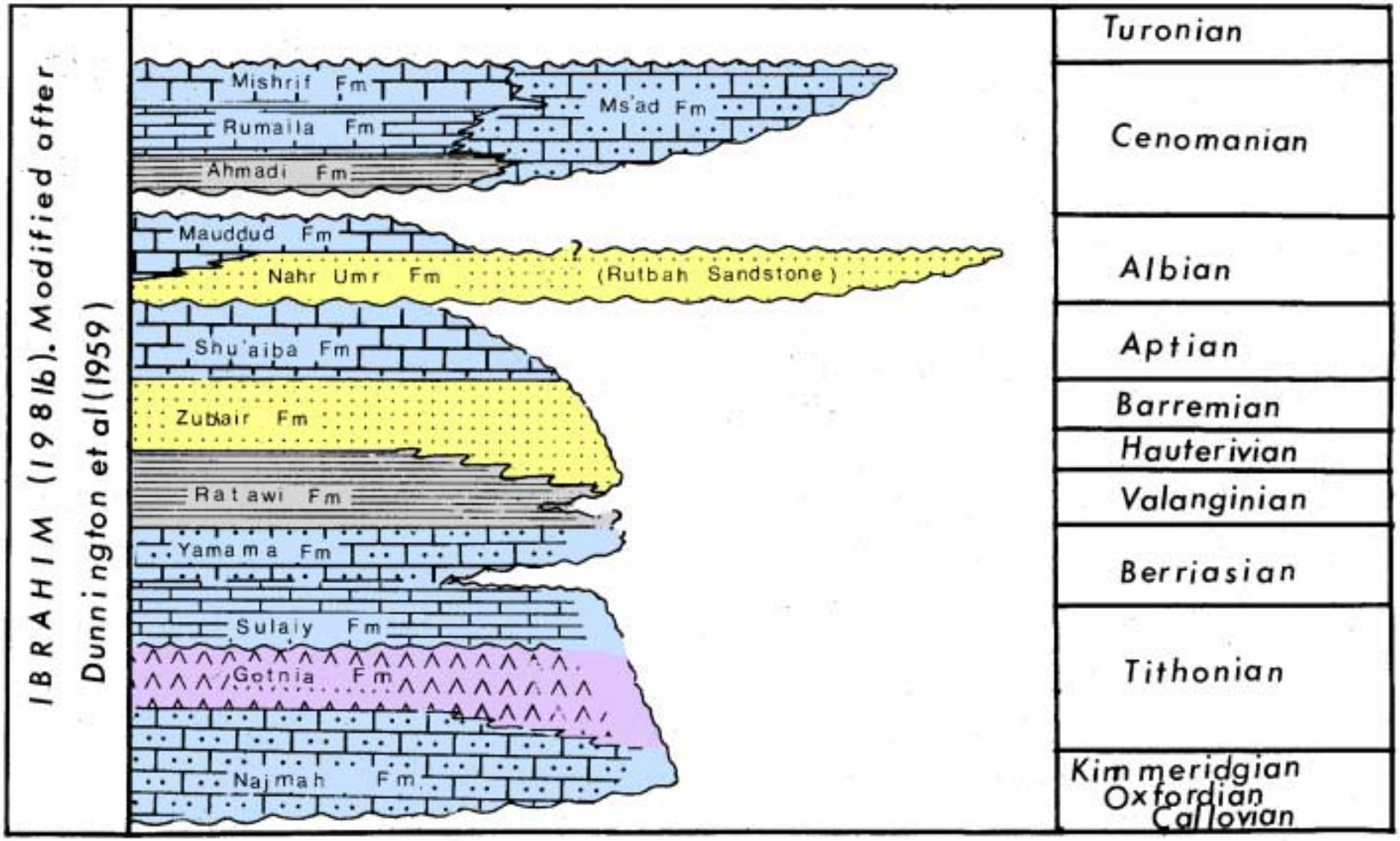



**Figure 16. Stratigraphic diagram of Middle Jurassic (Callovian) to Mid-Cretaceous (Cenomanian), Southern Iraq (after Ibrahim, 1983).**

| Periods, Epochs, Ages (Modified form Dunnington 1967) | | JORDAN | S.E. TURKEY | SYRIA | N. IRAQ | S.W. IRAN | OFFSHORE IRAN | CENTRAL & S. IRAQ | KUWAIT & DIVIDED ZONE | SAUDI ARABIA |
|---|---|---|---|---|---|---|---|---|---|---|
| MIO-PLIOCENE | MIO-PLIOCENE<br>M - U MIOCENE | | | | | | Fars : G. | | | |
| OLIGO-MIOCENE | L-M MIOCENE<br>OLIGO- | | | Jerribe : O.G.<br>Chilou : O.G. | "Main" O.G. Limestone : | Asmari : O.G. (Kalhor) | Ghar/Asmari : G.O. | "Ghar" : O. | | Belayim/Rudeis : G.O. (Red Sea basin) |
| EOCENE/ PALAEOCENE | U - M EOCENE<br>L.EOCENE-PALAEOCENE | | | Jaddala : O. | Avana/Jaddala /Aaliji : O. | | Jahrum : O. | | Dammam : O.G.<br>U. Rednume : O. | |
| | | | Sinan : O. | | | | | | | |
| CRETACEOUS U | MAESTRICHTIAN<br>U.CAMPANIAN<br>L.CAMPAN-/SANTONIAN<br>CONIACIAN | Ajlun Gp : O. (Hummar & Na'ur) | Garzan : O<br>Beloka : O.<br>Karabogaz : O. | Shiranish : O.G.<br>Rmeh : O.G.<br>"Massive" | Shiranish/ "Pilsner" : O. | Ilam : O. | Gurpi : O.<br>Magwa : O. | Hartha : O. | | |
| CRETACEOUS M | TURONIAN<br>CENOMANIAN<br>ALBIAN<br>APTIAN | | Karabebe : O.<br>+<br>Derdere : O. (Marclin) | Limestone : O.<br>"Judea" : O. | Kometan/ Dokan / O. "Gamchuqa" : | Sarvak : O. | (Mishrif)<br>Ahmadi : O.<br>Wara : O.<br>Mauddud : O.<br>Burgan : O. | Mishrif : O.<br>Nahr Umr : O. | Wara : O.<br>Mauddud : O.<br>Burgan : O. | Mishrif : O.<br>Rumaila : O.<br>Ahmadi : O.<br>Wara : O.<br>Mauddud : O.<br>Burgan : O.<br>Shuaiba : O. |
| CRETACEOUS L | BARREMIAN<br>HAUTERIVIAN<br>VALANGINIAN<br>BERRIASIAN | | | Rutbah : O. | L. Gamchuqa and O. Gargu: | Darkyan : G.<br>O.<br>Fahliyan : G. | Fahliyan : O. (Yamama) | Zubair : O.<br>Yamama : O. | Zubair : O.<br>Minagish : O. (Ratawi) | Biyadh : (Zubair) : O.<br>Bubuaib : O.<br>Yamama : O.<br>Sulaiy : O. |
| JURASSIC U | PORTLANDIAN-<br>M. KIMMERIDGIAN<br>L. KIMMERIDGIAN<br>OXFORDIAN/CALLOVIAN | | | | | | Araix O.<br>Arab D : O. | | | Hith : O.<br>Arab A-C : O.<br>Arab D : O<br>Jubeila : O.<br>Hanifa : O.<br>Tuwaiq : O. |
| JURASSIC M | BATHONIAN<br>BAJOCIAN | | | | | | | Najmah : O. | | Dhruma : O. |
| JURASSIC L | LIASSIC<br>L. LIASSIC | | Camurlu : G | Butmah : O. | | | | | Marrat : O. | |
| | TRIASSIC | | | Kurachine : O.G.<br>(Muluesa) : G.O. | Kurachine : O. | Kangan : G. | | | | |
| PALEOZOIC | PERMIAN<br>PERMO-CARBONIFEROUS | | | Markadah : G. | | Dalan : G. | Dalan : G. | | ? Khuff : G. | Khuff : G.<br>Unayza : O,G. |
| PALEOZOIC | CARBONIFEROUS<br>SILURIAN-DEVONIAN | "Sands" : G. | Katin : G.O. | | | | | | | |
| PALEOZOIC | CAMBRO-ORDOVICIAN | | | | | | | | | |
| PALEOZOIC | CAMBRIAN / INFRA-CAMBRIAN | | | | | | | | | |

O = Oil  G = Gas, as predominant production  G after O = Gas alone in some fields  Condensate in many of the non-Permian Gas fields

**Figure 17. Producing stratigraphic units of the Arabian Plate (after Beydoun, 1991).**

| Field | Oil or Gas | FIELD SIZE OIL, MMBO | FIELD SIZE GAS, TCF | FIELD SIZE EQUIV, MMBOE | ESTIMATE, REMAINING EQUIV, MMBOE | Lat | Long | D.Y. | BALLY | KLEMME | ST. JOHN (modified) PROVINCE | Depth (feet) | Primary Trap | Lithology | Age | Depth. Km | Ma |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Abu Ghirab | o | 638 | | 638 | 213 | 32.23 | 47.23 | 1971 | 41 | IICa | Zagros (46 | 9810 | Anticline | carbonate | Miocene L | 2.99 | 24 |
| Ahdab | o | 500 | 0.1 | 517 | 225 | 32.28 | 45.40 | 1979 | 221 | IICa | Arabian (45 | 8038 | Anticline | limestone | Coniacian | 2.45 | 89 |
| Akkas | o | 100 | 2.5 | 517 | 353 | 34.11 | 40.57 | 1992 | 221 | IICa | Arabian (45 | 0 | | | | 0.00 | |
| Baghdad, East | o | 2000 | | 2,000 | 871 | 33.08 | 44.30 | 1979 | 221 | IICa | Arabian (45 | 10000 | Anticline | sandstone | Cretaceous | 3.05 | 99 |
| Baghdad, West | o | 1000 | 0.1 | 1,023 | 215 | 33.27 | 43.36 | 1958 | 222 | IICa | Arabian (45 | 2385 | Anticline | dolomitic limestone | Maastrichtian | 0.73 | 71 |
| Bai Hassan | o | 1882 | | 1,882 | 358 | 35.38 | 44.02 | 1953 | 41 | IICa | Zagros (46 | 1750 | Anticline | limestone | Miocene L | 0.53 | 24 |
| Gharraf | o | 500 | | 500 | 218 | 31.44 | 46.05 | 1979 | 221 | IICa | Arabian (45 | 10007 | Anticline | limestone | Hauterivian | 3.05 | 132 |
| Halfayah | o | 700 | 0.7 | 817 | 320 | 31.40 | 47.29 | 1976 | 221 | IICa | Arabian (45 | 2408 | Anticline | limestone | Miocene | 0.73 | 24 |
| Hamrin | o | 580 | 0.8 | 713 | 166 | 34.50 | 44.03 | 1961 | 41 | IICa | Zagros (46 | 1398 | Fold | limestone | Miocene L | 0.43 | 24 |
| Jabal Fauqui | o | 1000 | | 1,000 | 346 | 32.00 | 47.39 | 1974 | 41 | IICa | Zagros (46 | 10000 | Anticline | carbonate | Miocene | 3.05 | 15 |
| Jambur | o | 2629 | | 2,629 | 1586 | 35.08 | 44.34 | 1954 | 41 | IICa | Zagros (46 | 4200 | Anticline | dolomitic limestone | Miocene L | 1.28 | 24 |
| Khabbaz | o | 500 | | 500 | 268 | 35.29 | 44.12 | 1985 | 41 | IICa | Zagros (464) | | Anticline | limestone | Miocene L | | 24 |
| Kirkuk | o | 17000 | | 17,000 | 5866 | 34.45 | 44.11 | 1927 | 41 | IICa | Zagros (46 | 2800 | Anticline | carbonate | Oligocene | 0.85 | 33 |
| Luhais | o | 500 | | 500 | 143 | 30.18 | 46.46 | 1961 | 221 | IICa | Arabian (45 | 8000 | Anticline | sandstone | Cretaceous | 2.44 | 99 |
| Majnoon | o | 12000 | 11.0 | 13,833 | 9487 | 31.08 | 47.36 | 1977 | 221 | IICa | Arabian (45 | 7874 | Anticline | limestone | Turonian | 2.40 | 94 |
| Mansuriyah | g | 50 | 3.3 | 600 | 252 | | | 1978 | 41 | IICa | Zagros (46 | 4003 | Anticline | limestone | Miocene L | 1.22 | 24 |
| Nahr Umr | o | 1000 | | 1,000 | 219 | 30.46 | 47.42 | 1948 | 221 | IICa | Arabian (45 | 9000 | Anticline | sandstone | Cretaceous | 2.74 | 99 |
| Nasiryah | o | 500 | | 500 | 210 | 31.19 | 46.01 | 1978 | 221 | IICa | Arabian (45 | 6516 | Anticline | limestone | Turonian | 1.99 | 94 |
| Noor | o | 500 | | 500 | 203 | 31.57 | 47.17 | 1977 | 221 | IICa | Arabian (45 | 13435 | Anticline | sandstone | Albian | 4.10 | 112 |
| Rachi | o | 870 | | 870 | 177 | 30.14 | 47.02 | 1957 | 221 | IICa | Arabian (45 | 9475 | Anticline | sandstone | Aptian L | 2.89 | 121 |
| Ratawi | o | 1400 | 0.7 | 1,517 | 242 | 30.33 | 47.06 | 1950 | 221 | IICa | Arabian (45 | 7018 | Anticline | limestone | Turonian | 2.14 | 94 |
| Rumaila North & South | o | 22000 | | 22,000 | 11022 | 30.26 | 47.20 | 1953 | 221 | IICa | Arabian (45 | 10650 | Anticline | sandstone | Cretaceous | 3.25 | 99 |
| Saddam | o | 500 | 1.0 | 667 | 280 | 34.52 | 43.53 | 1978 | 41 | IICa | Zagros (46 | 2408 | Anticline | limestone | Miocene | 0.73 | 24 |
| Safwan | o | 500 | 0.4 | 558 | 227 | 30.06 | 47.45 | 1977 | 221 | IICa | Arabian (45 | 10591 | Anticline | sandstone | Aptian L | 3.23 | 121 |
| Subba | o | 770 | | 770 | 474 | 30.48 | 46.41 | 1989 | 221 | IICa | Arabian (450.07-450G) Northern Mesopotamian Foredeep Basin | | | | | | |
| Tuba | o | 500 | 0.4 | 558 | 122 | 30.25 | 47.27 | 1959 | 221 | IICa | Arabian (45 | 7585 | Anticline | dolomite | Turonian | 2.31 | 94 |
| West Qurna | o | 4885 | | 4,885 | 4827 | 31.06 | 47.16 | 1987 | 222 | IICa | Arabian (45 | 12139 | Anticlinal shoals | marly limestones | Jurassic & Cretaceous | 3.70 | 144 |
| Zubair | o | 6731 | | 6,731 | 3241 | 30.23 | 47.39 | 1949 | 221 | IICa | Arabian (45 | 10827 | Anticline | sandstone | Barremian | 3.30 | 127 |

Table 1. Database of giant fields in Iraq, showing basic geologic features and estimates of ultimate recovery and reserves (from Horn, 2003 [with minor revision]). Basic data sources for Horn (2003): Halbouty et al., 1970; Carmalt and St. John, 1986; I.H.S. Energy Group, 1998, Selected giant field data (with kind permission to publish granted 2002); supported by 35 additional sources.

## Geologic Considerations

Iraq is part of the Zagros and Arabian sedimentary provinces, according to St. John et al. (1984) (Figure 1). The former is a folded belt, related to A-subduction; and the Arabian province is a foredeep, in which the ramp has buried grabens, but with little blockfaulting (St. John et al., 1984). Fields are present in both provinces (Figures 2, 3, and 4). Konert et al. (2001) consider the foredeep in front of the Zagros (Figures 5 and 6) as a part of a very widespread stable platform. Versfelt (2001) shows the Zagros "Foreland Basin" to flank the the Zagros mountain front from the northeast-trending Khleissia high in the north to Hormuz in the south (Figure 6). The Zagros sedimentary province includes the Kirkuk (Sirwan) embayment, Lurestan, Dezful Embayment (Khuzestan), and Fars, the last three being predominantly in Iran. The embayments are the most prolific oil-producing areas. The fields, generally spectacular anticlines, trend northwest, except north of Mosul, where the folded belt becomes more easterly (Figure 7). Outside the Zagros belt are north-trending fields (e.g., Rumaila) and northwest-trending fields (e.g., East Baghdad). The fields in Southern Iraq trending north seemingly are related to fields in Kuwait and Saudi Arabia with similar orientation, which parallels extensional fault trends. Maps of fields, cross-sections, and generalized stratigraphic columns/diagrams are shown in Figures 8-16.

Reservoirs range in age from Miocene to Triassic. Paleozoic petroleum systems are known to exist in parts of northwest Iraq (Konert et al., 2001) and possibly in the west as well (Beydoun, 1991). Stratigraphic column for Northern Iraq is given in Figure 14. A diagram of Middle Jurassic to Mid-Cretaceous strata in Southern Iraq is presented in Figure 16. Producing stratigraphic units are shown in Figure 17.

Both carbonates and sandstones are well represented as reservoir rocks. Sandstones are commonly more significant as reservoirs outside the main part of the Zagros province, whereas carbonates are dominant in the main part of the Zagros. Miocene-Oligocene-Eocene are most likely to be productive southwest of the "mountain front" (Versfelt, 2001), where the Miocene evaporite (seal) is preserved (Figure 6).

Source rocks have been identified in the Eocene-Paleocene, Upper Cretaceous, Mid- to Lower Cretaceous, Upper Jurassic, Middle Jurassic, and Triassic (Versfelt, 2001). Silurian source rock has been documented in western/northwestern Iraq (Konert et al., 2001).

As shown in the database of giant fields of Iraq (Table 1) (M.K. Horn, 2003), there are 28 giant fields in Iraq; 27 are classified as oil fields. Discovered in 1953, the largest field is Rumaila (Figure 15), 9$^{th}$ largest in the world (3$^{rd}$ largest oil field) with 22 BOE. It is in Southern Iraq and the Arabian sedimentary province. Kirkuk (Figures 8 and 9), the second largest Iraqi field with 17 BOE, is in Northern Iraq and the Zagros province. Discovered in 1927, it is the 17$^{th}$ largest field (8$^{th}$ largest oil field) in the world. Ultimate recovery from the giant fields of Iraq is estimated to be 85 BOE; for comparison, the estimate for North Dome Gas Field in Qatar is 160 BOE, and 97 BOE for Ghawar Oil Field in Saudi Arabia. Remaining recovery, or reserves, for the Iraqi giant fields is estimated to be 41 BOE (Horn, 2003), or approximately one-half of the ultimate recovery. More than a decade ago, ultimate recoverable petroleum reserves of the Arabian Plate region was estimated to be almost 900 BOE, with approximately 98% being in the Zagros and Arabian sedimentary provinces (Beydoun, 1991).

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