Geology: from Greek, Geo = Earth,

Logos = Science

is the science that deals with the study of the earth as a whole i.e.

* **Origin:** (Theories)

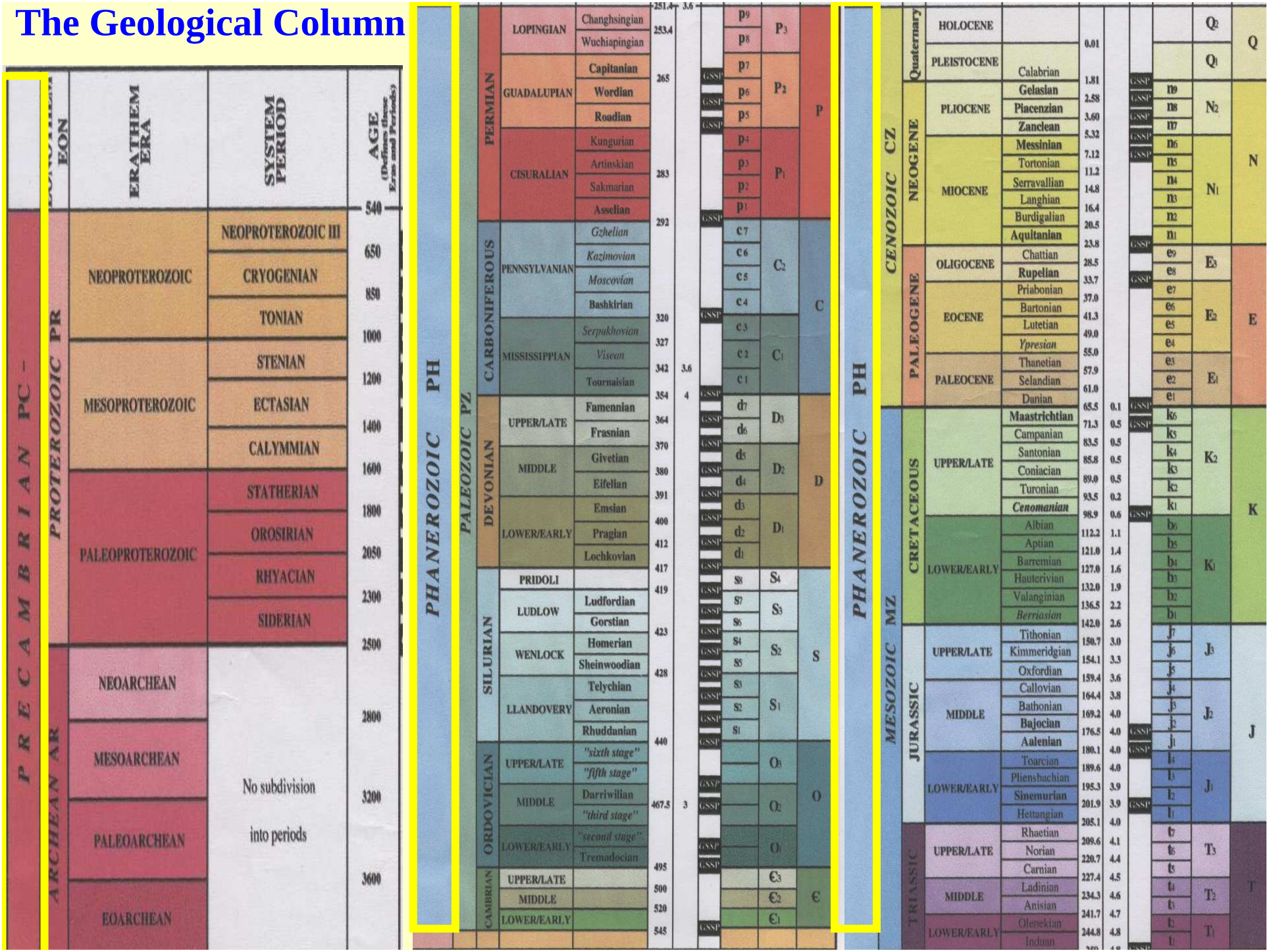
* **Age:** (4,500 M.y.)

• **Evolution:** (Differentiation)

• **Internal Structures:** (Crust, Mantle, Core)

* **Modification:** (Weathering etc).

The Geological Column



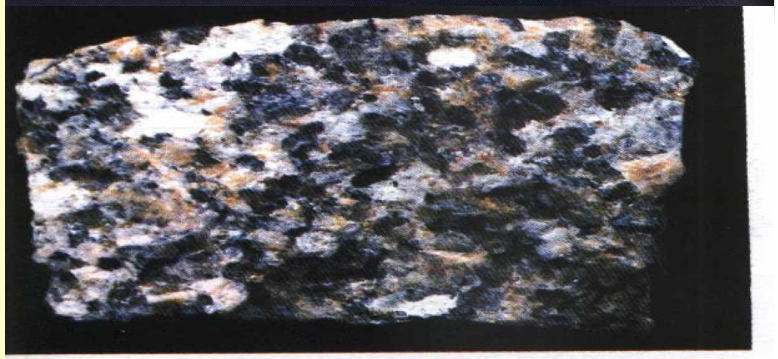
Type of Rocks:

1. Igneous Rocks:

The rocks that formed from molten materials

1. **Compacted**
2. **Massive**
3. **Hard**
5. **Consolidated**

شكل 3 ـ 4
نسيج حويصلي. تتكون الحويصلات عند تصاعد فقاقيع الغازات قرب السطح العلوى لطفوح اللابة.



ب

شكل 3 ـ 9
(أ) ـ جرانيت. أحد الصخور النارية خشنة الحبيبات، الأكثر شيوعا.
(ب) ـ رايوليت. الصخر دقيق الحبيبات المقابل للجرانيت هو أقل وفرة.

نسيج الصخور النارية. (أ) ـ نسيج دقيق. (ب) ـ نسيج خشن. (جـ) ـ نسيج متباين. (د) ـ نسيج زجاجي.

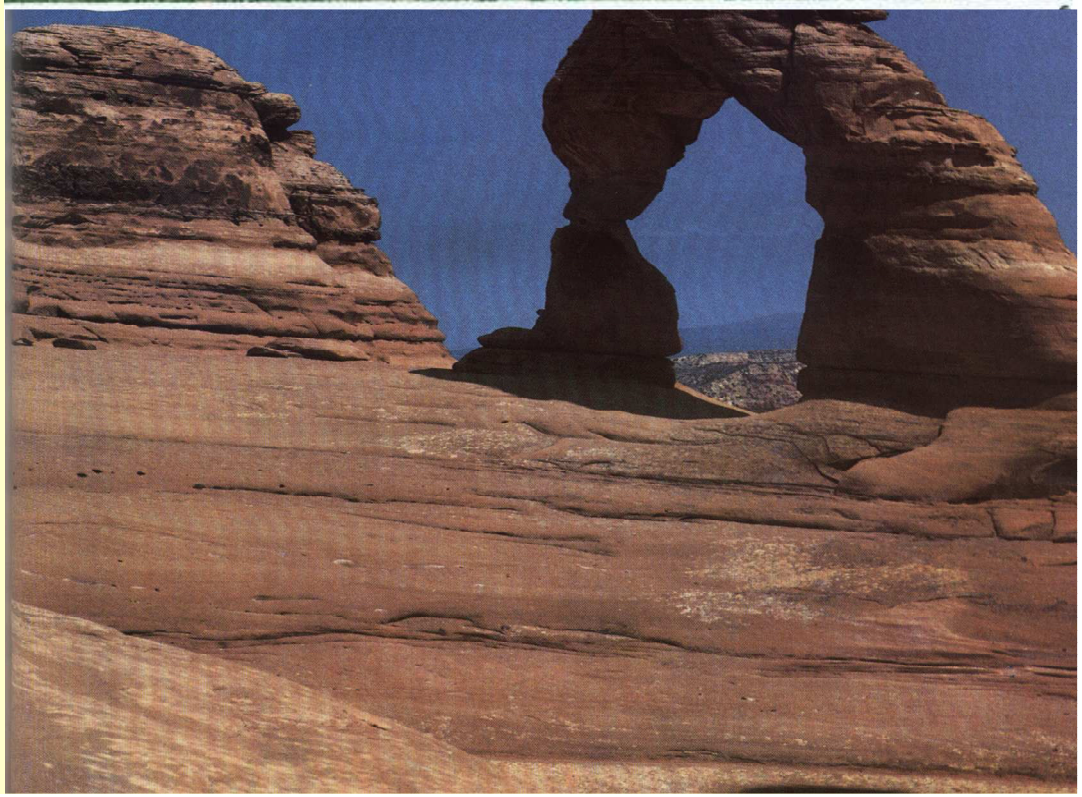
2. Sedimentary Rocks:

The rocks that :

- Deposited under normal conditions of temperature and pressure.

- They have been formed by physical or chemical weathering of the pre-existing rocks.

1. **Soft**
2. **Porous**
3. **Stratified**



The Sedimentary Rocks can be divide into 2 types:

1. Sedimentary Deterial Rocks:

2. Sedimentary chemical Rocks:

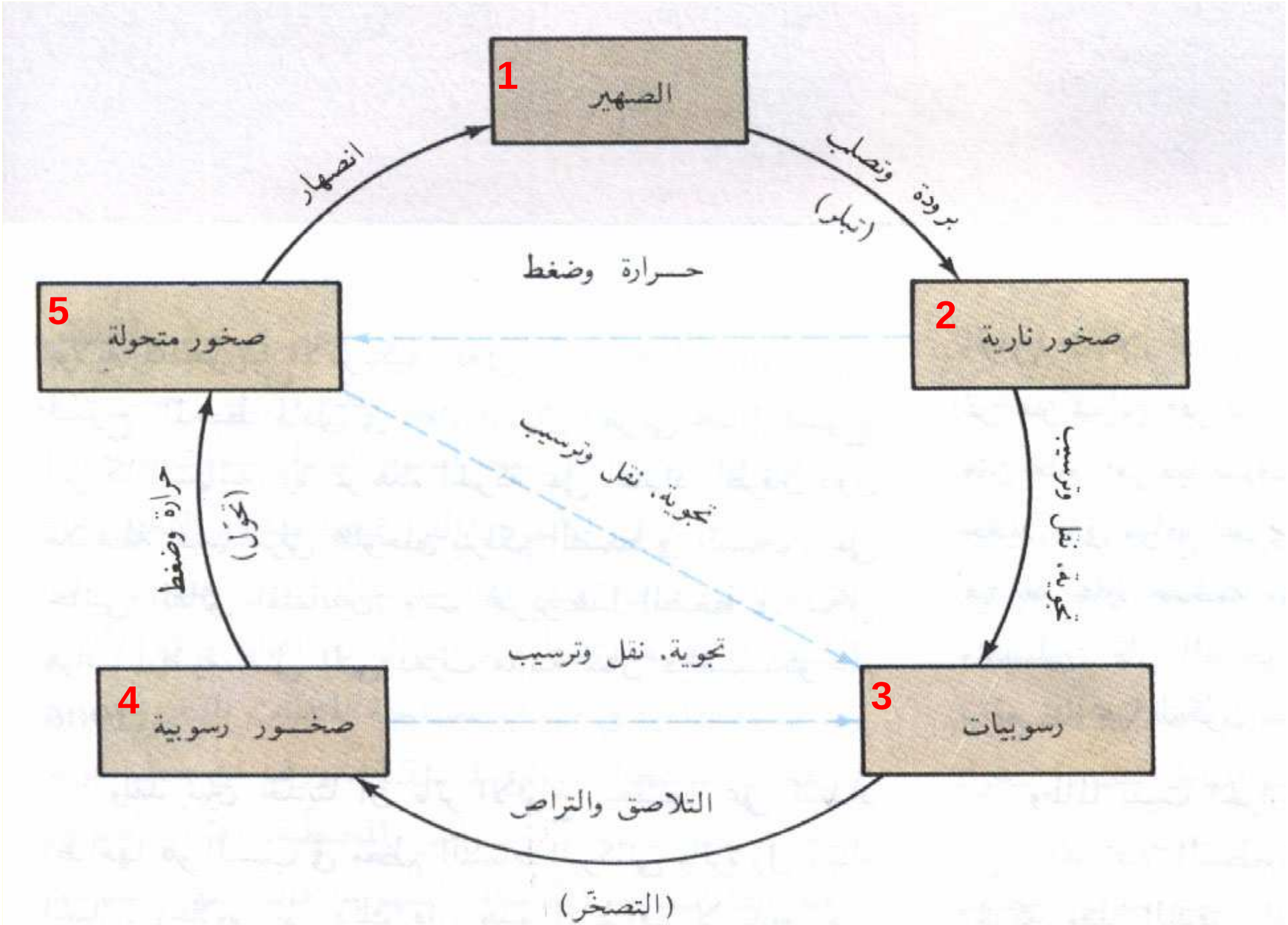
- Gypsum
- Salt Rocks
- Anhydrite

شكل 6 ـ 4
جدران الجس الأبيض قرب مدينة دوفر.

3. Metamorphic Rocks:

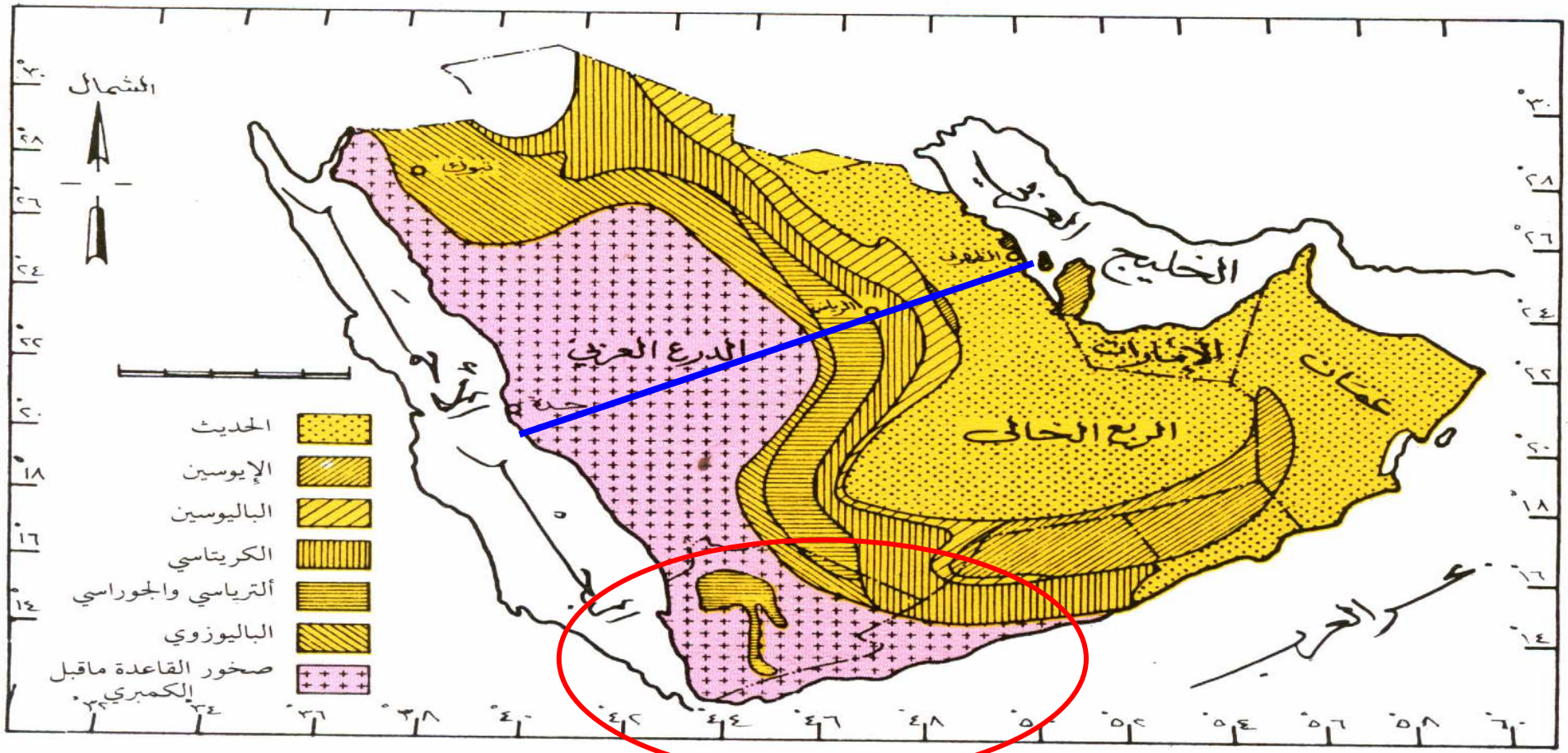
The rocks which are transformed from pre-existing rocks (igneous or sedimentary) by the effect of great heat and pressure

1. **Hard**
2. **Compact**
3. **Consolidated**

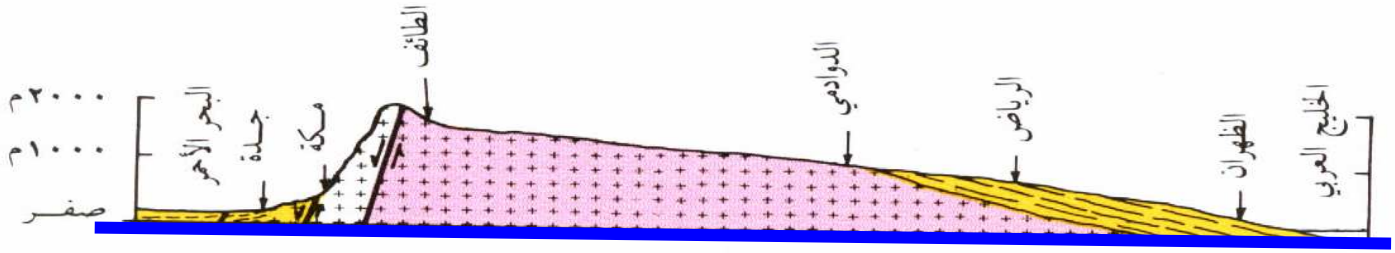

1
الصهير
2
صخور نارية
3
رسوبيات
4
صخور رسوبية
5
صخور متحولة
انصهار
برودة وتصلب
(تبلر)
حرارة وضغط
(تحول)
حرارة وضغط
تجوية، نقل وترسيب
تجوية، نقل وترسيب
تجوية، نقل وترسيب
التلاصق والتراص
(التصخر)

Sources of Information on geology of Yemen

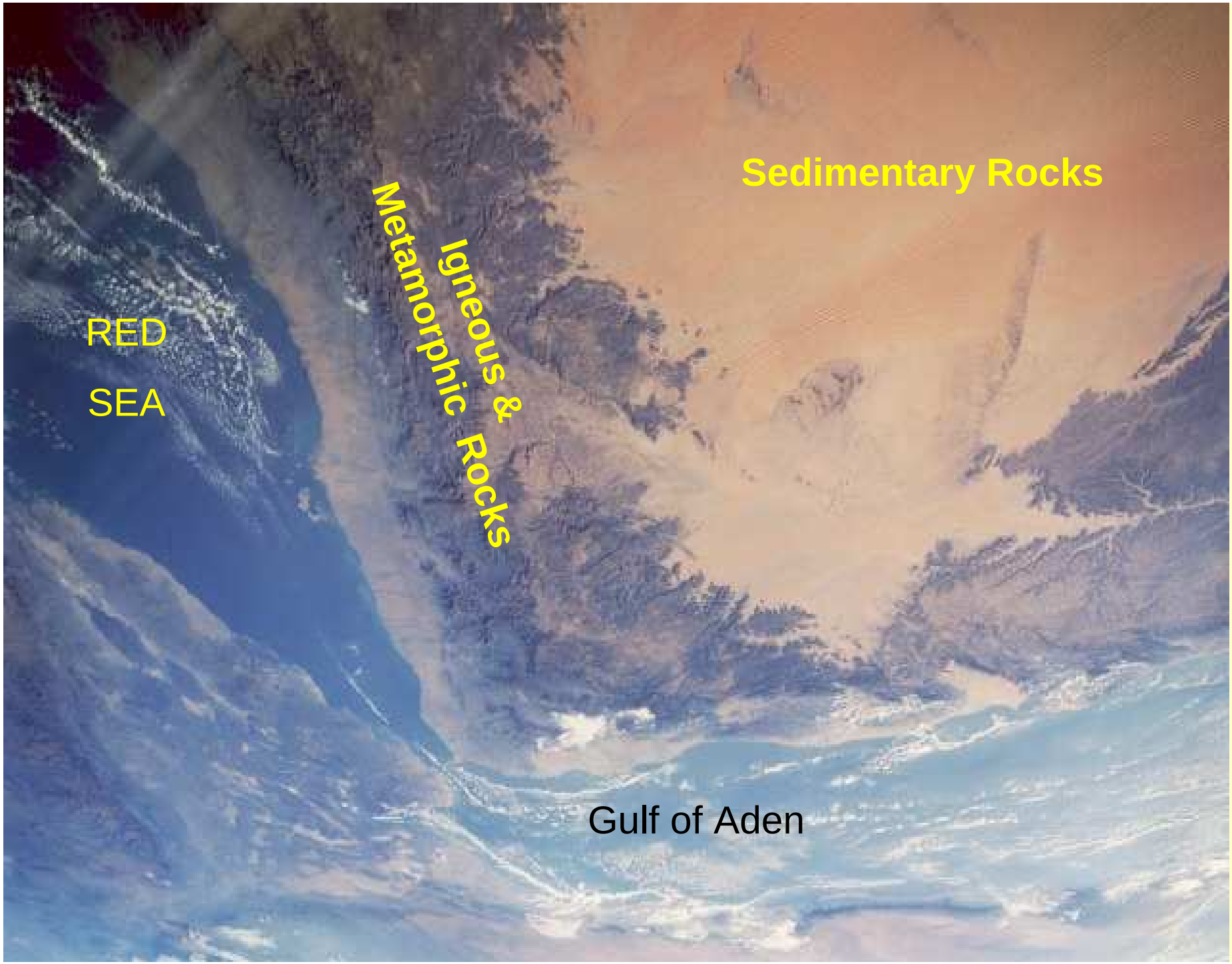
1. **Beydoun (1964)**
2. **Guekens (1966)**
3. **Grolier and Overstreet (1978)**
4. **El-Anbaawy (1985)**
5. **The Arab Organization for Mineral Resources (1986) and**
6. **Robertson (1991) etc.**



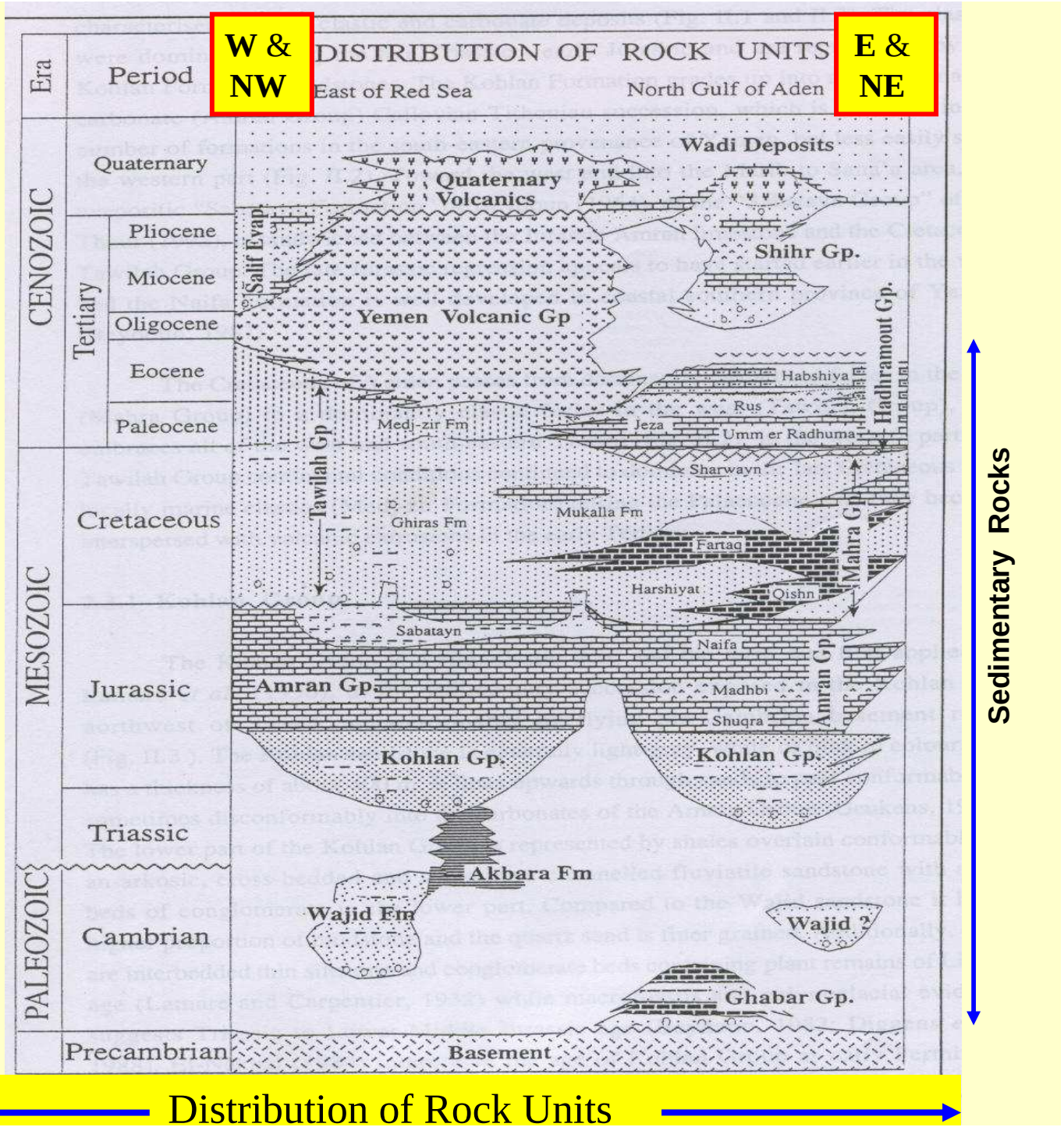
شكل (١ – أ) خريطة جيولوجية – شبه الجزيرة العربية

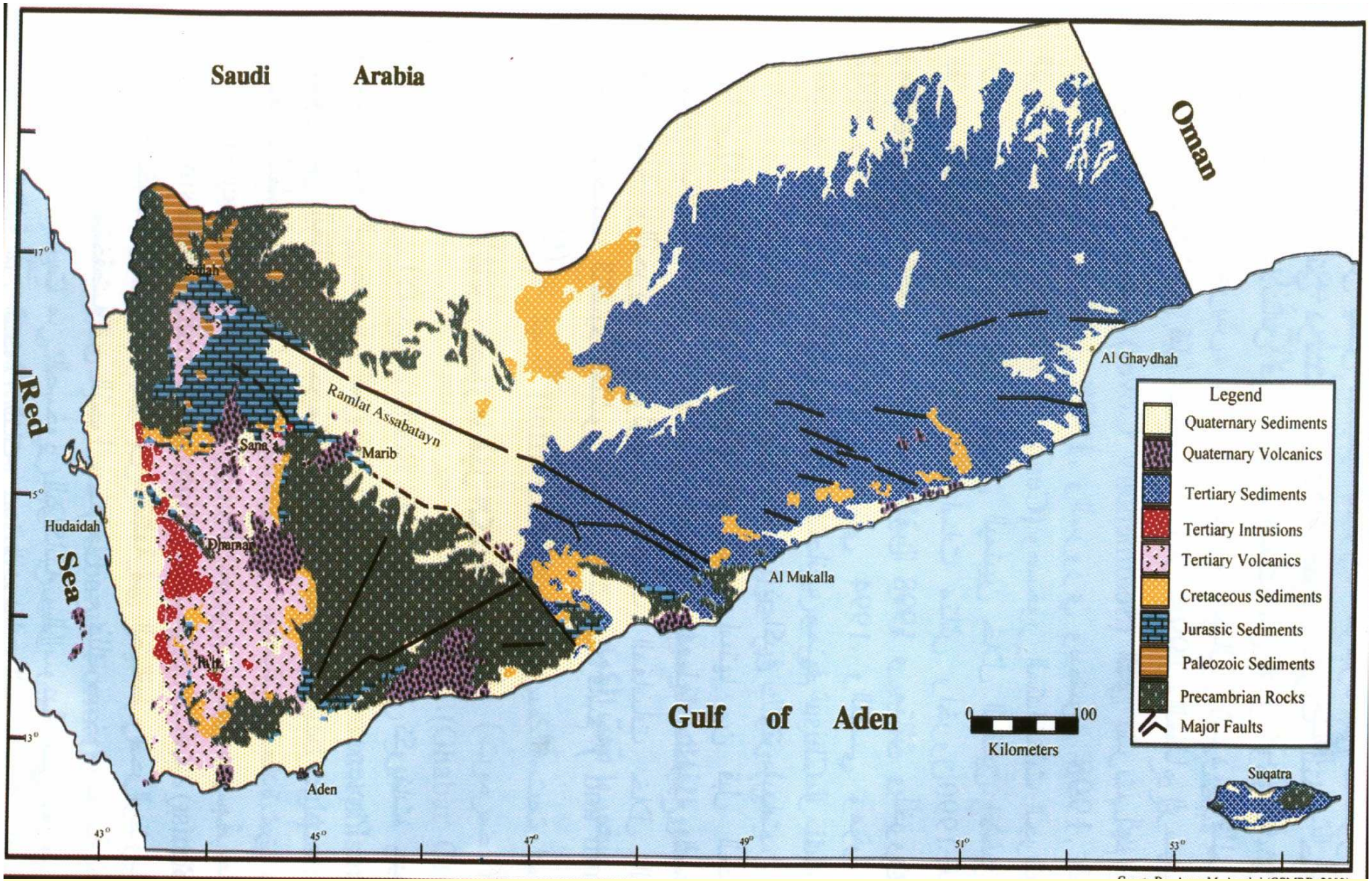


شكل (١ – ب) مقطع جيولوجي تخطيطي عام عبر المملكة العربية السعودية من الشرق (الخليج العربي) حتى الغرب (البحر الأحمر)


Sedimentary Rocks
Igneous &
Metamorphic Rocks
RED
SEA
Gulf of Aden

Stratigraphy of Yemen

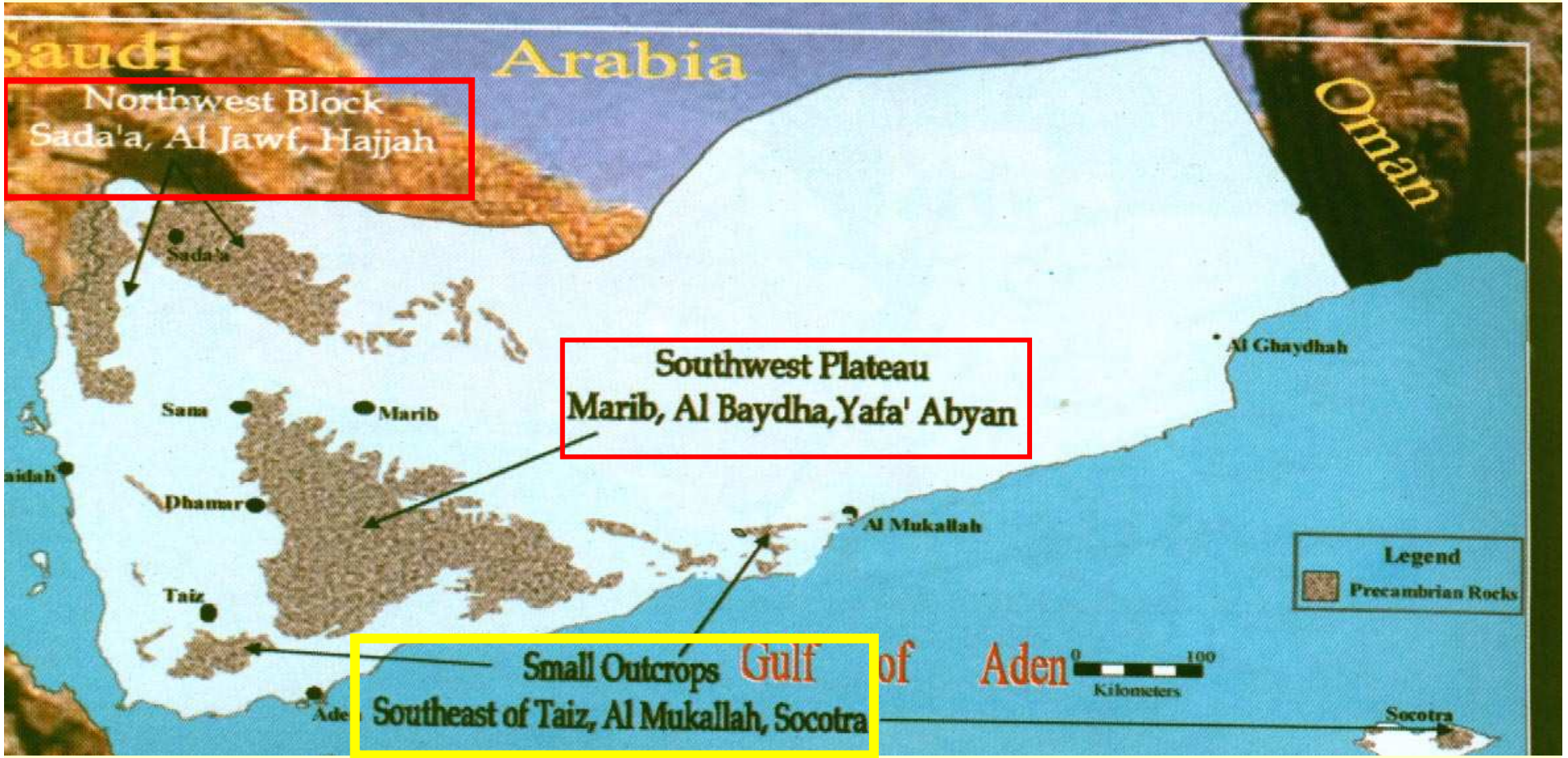




A Geological Map of Yemen

I. Precambrian Basement Rock

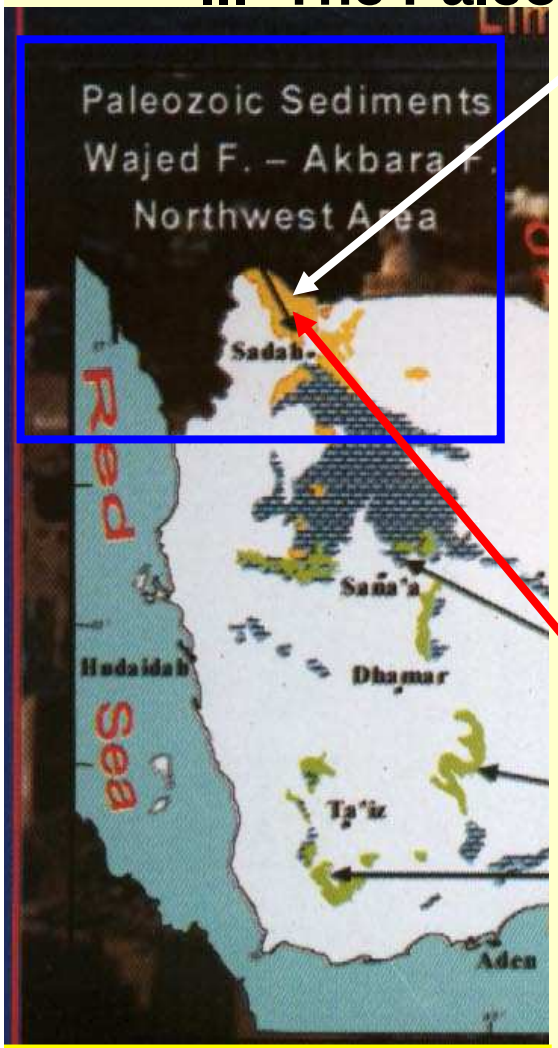
- They underlie all the sub horizontal sedimentary successions.
- They consist of : amphiboltes, migmatites, gneiss and large granitic massifs



They crop out mainly in :

1. Marib, Al-Baydha, Yafa, Abyan
2. Along the outer fringe of the country,

II. The Paleozoic Sedimentary Rocks



They are represented by:

1. Wajid Formation

&

2. Akbra Formation

1. Wajid Formation :

Definition : 1st defined by Gierhard and Owers (1948)

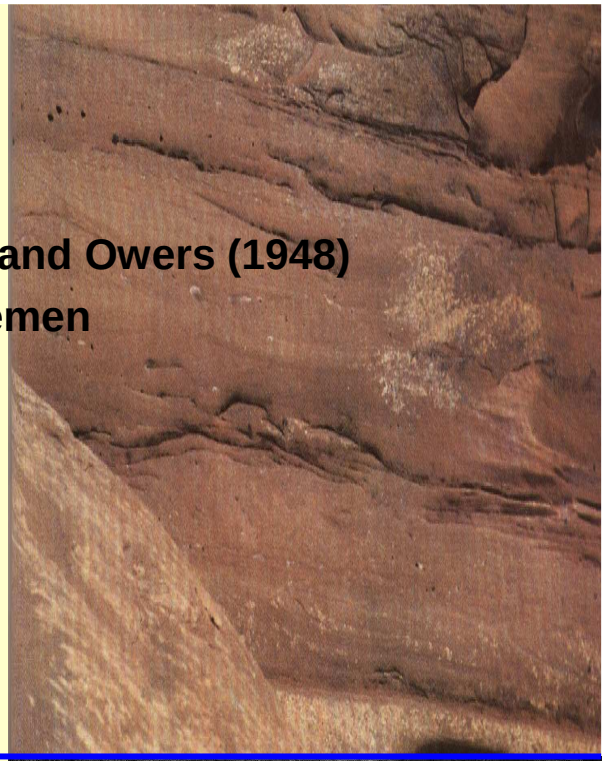
Locality (Type Section): Sadah, Yemen
Southern Saudi Arabia,

Thickness:

About 200 m – in Yemen, and
950 m in Saudi Arabia

Rock types: Sandstone

Age: Cambro- Ordovician



2. Akbara Formation:

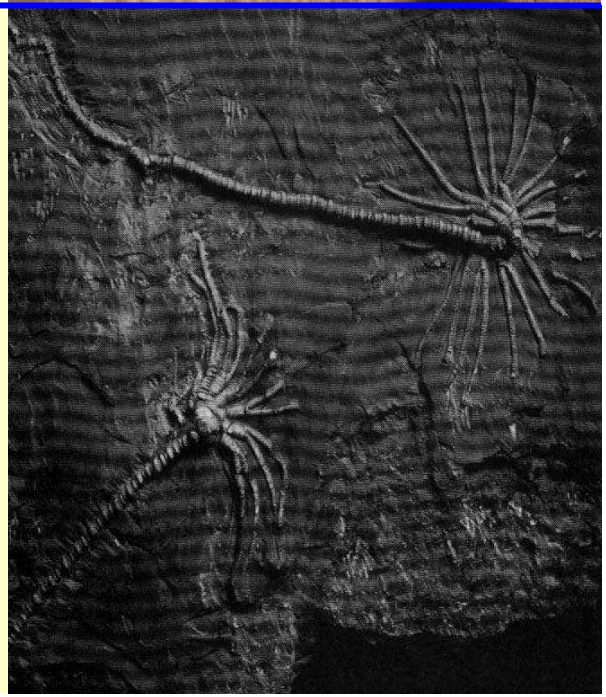
Definition: 1st defined by Roland (1976)

Locality: Wadi Akbara
southwest of Sadah Provenance.

Thickness: 40 to 80 m

Rock types: Banded Shale

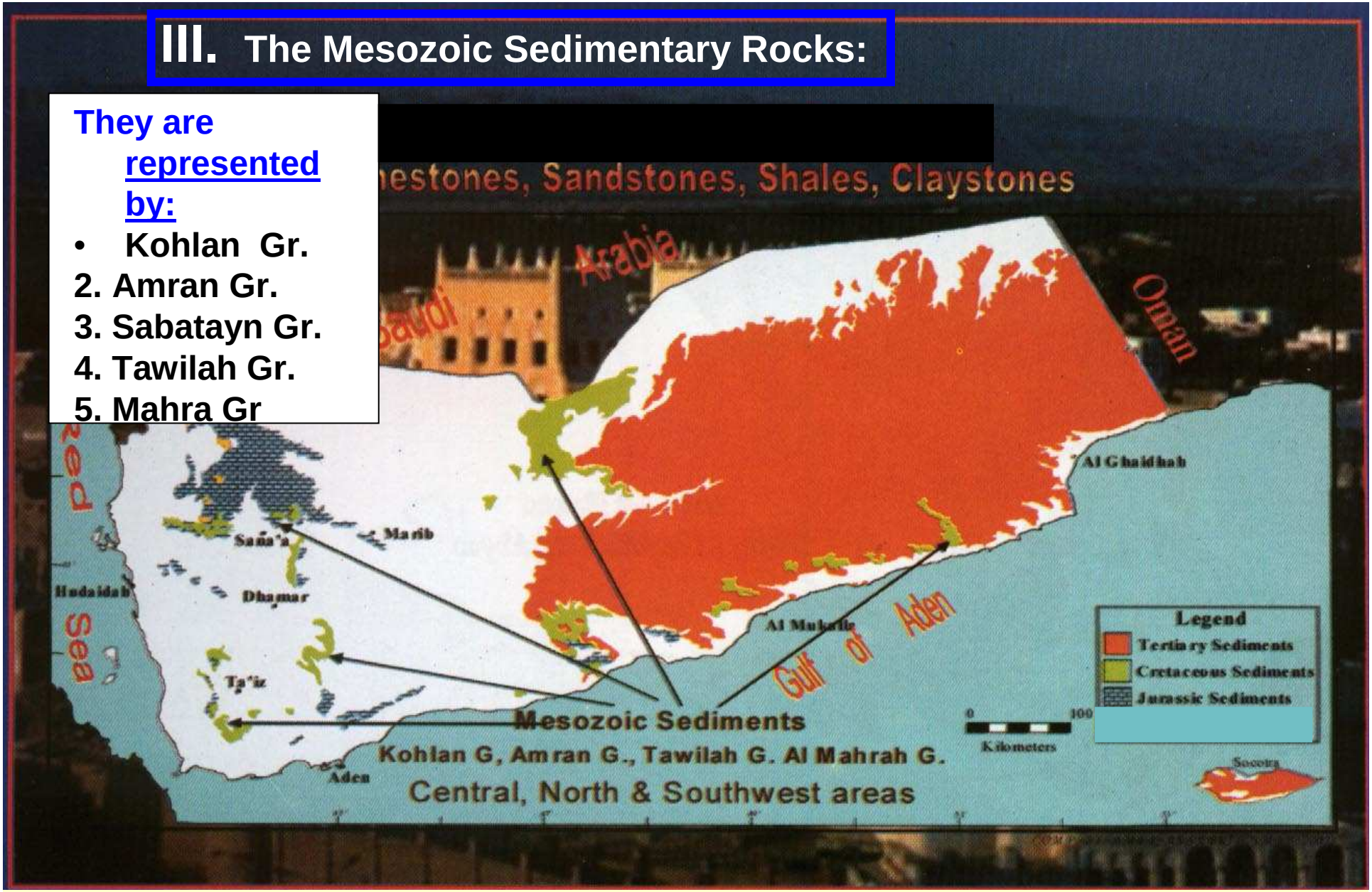
Age: Lower Permian



III. The Mesozoic Sedimentary Rocks:

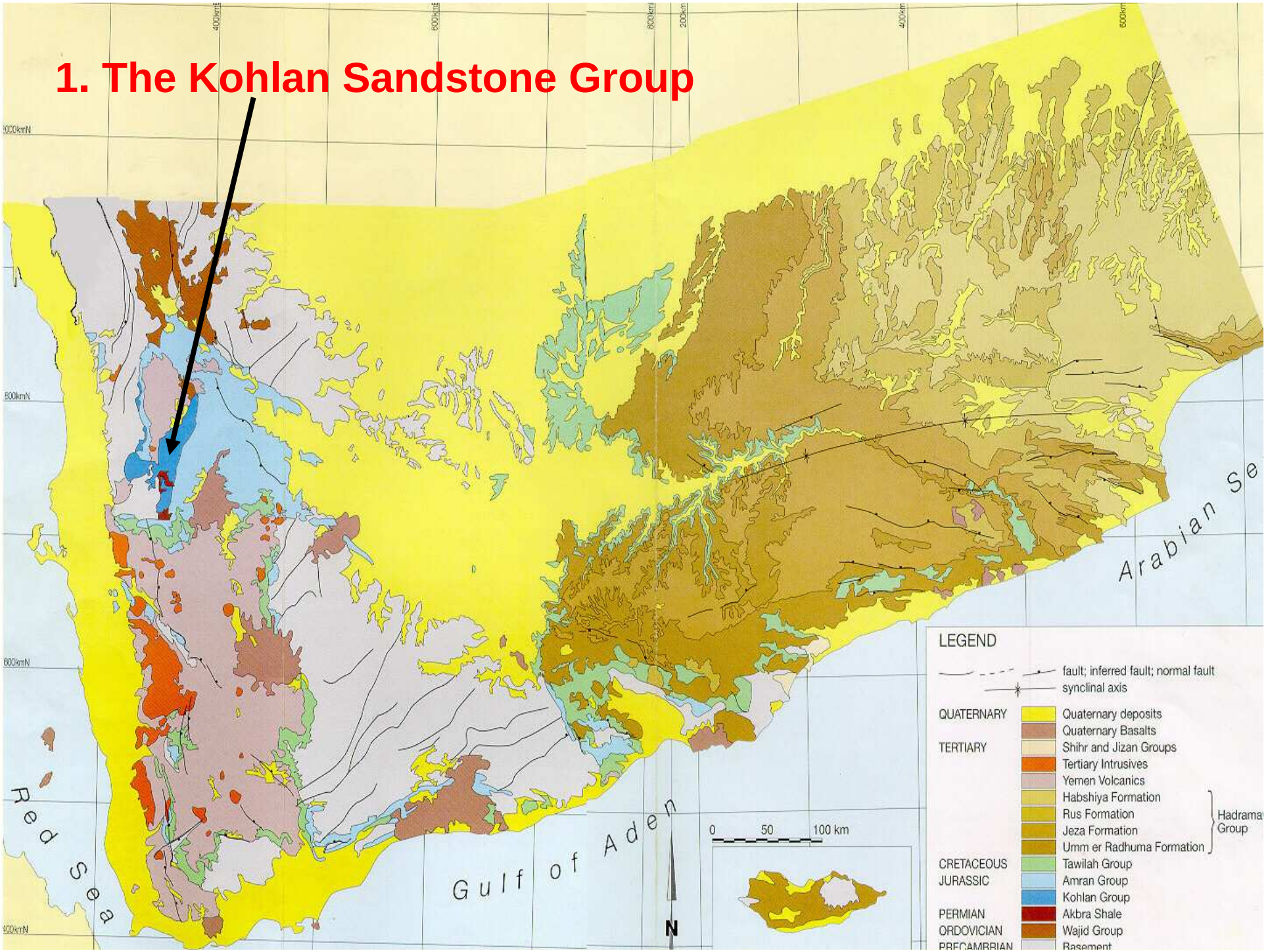
They are represented by:

- Kohlan Gr.
2. Amran Gr.
3. Sabatayn Gr.
4. Tawilah Gr.
5. Mahra Gr



-They characterized by both clasic and carbonate rocks.

-The Mesozoic sediments are widely distributed in Yemen


1. The Kohlan Sandstone Group
Red Sea
Gulf of Aden
Arabian Se
0 50 100 km
N
LEGEND
fault; inferred fault; normal fault
synclinal axis
QUATERNARY
Quaternary deposits
Quaternary Basalts
TERTIARY
Shihr and Jizan Groups
Tertiary Intrusives
Yemen Volcanics
Habshiya Formation
Rus Formation
Jeza Formation
Umm er Radhuma Formation
Hadrama
Group
CRETACEOUS
Tawilah Group
JURASSIC
Amran Group
Kohlan Group
PERMIAN
Akbra Shale
ORDOVICIAN
Wajid Group
PRECAMBRIAN
Basement

1. The Kohlan Sandstone Group

- It is a minor unit with a small thickness,

- It consists mainly of sandstone

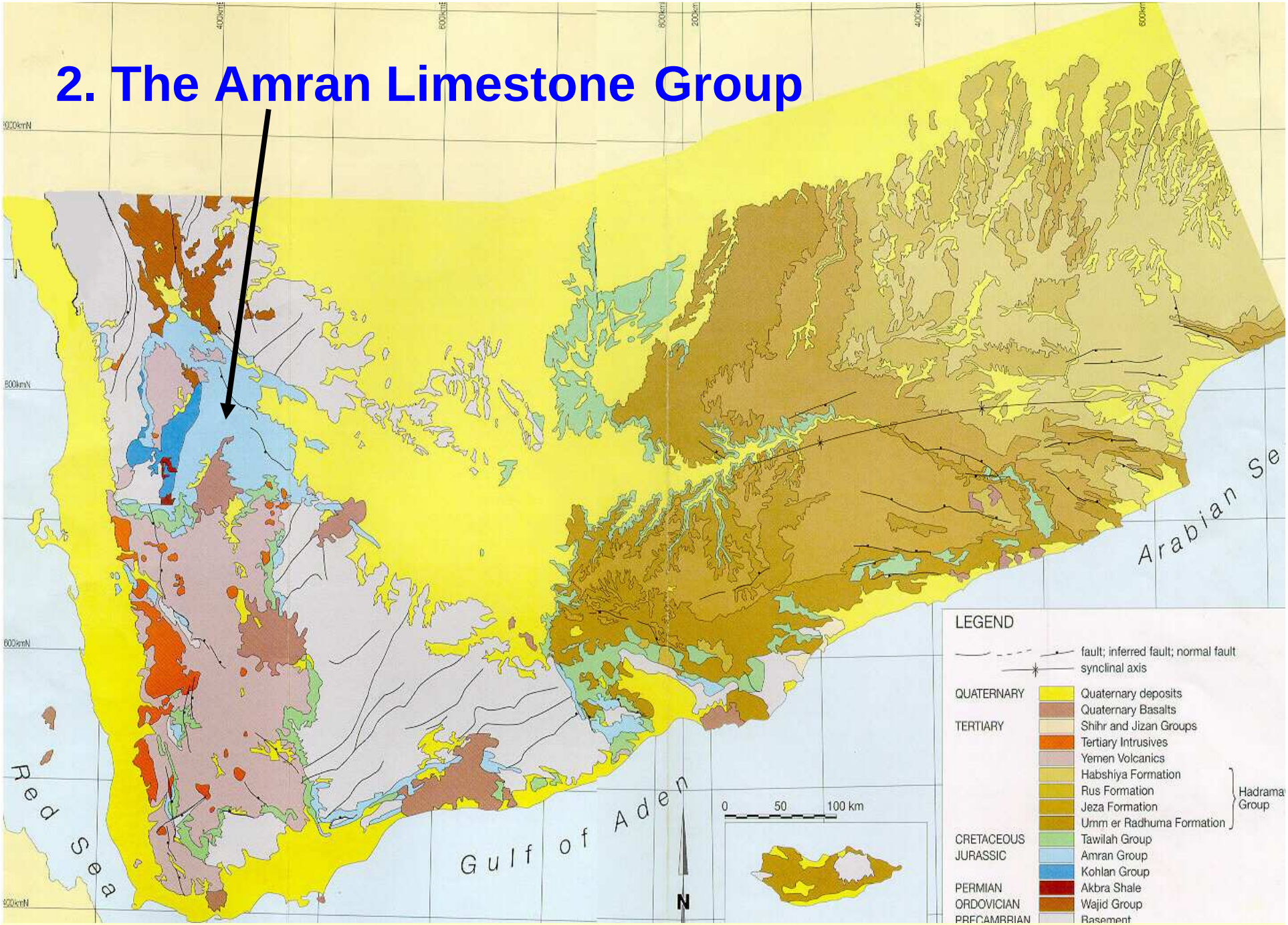
•**Definition:** 1st defined by Lamare et al., (1930

•**Locality**: Kohlan area N-W of Sana'a

•**Thickness**: The thickness is variable, with an average of some 60 meters.

•**Age**: Lower Jurassic

2. The Amran Limestone Group



2. The Amran Limestone Group

Definition: 1st defined by Lamare et al., 1930

Locality : Amran Town, 40 km to the N-W of Sana'a

Thickness: variable, with an average 500 – 1000 m.

Rock types: Carbonate rocks

Origin: Marine

Age: Jurassic

Amran Group has been subdivide into four formations arranged from older to younger as follows:

1. ***Shuqra***
2. ***Madbi / Sabateen***
3. ***Nayfa***
1. ***Al-Ahjur***

In Al-Jawf graben, the Amran group subdivided (From bottom to top) into four formations:

1. ***Saba***
2. ***Arwa***
3. ***Meem and***
4. ***Lam***

3. The Sabatayn Group

Definition: Defined by many workers, and it ranked to a Group by Al-Thour, (1992)

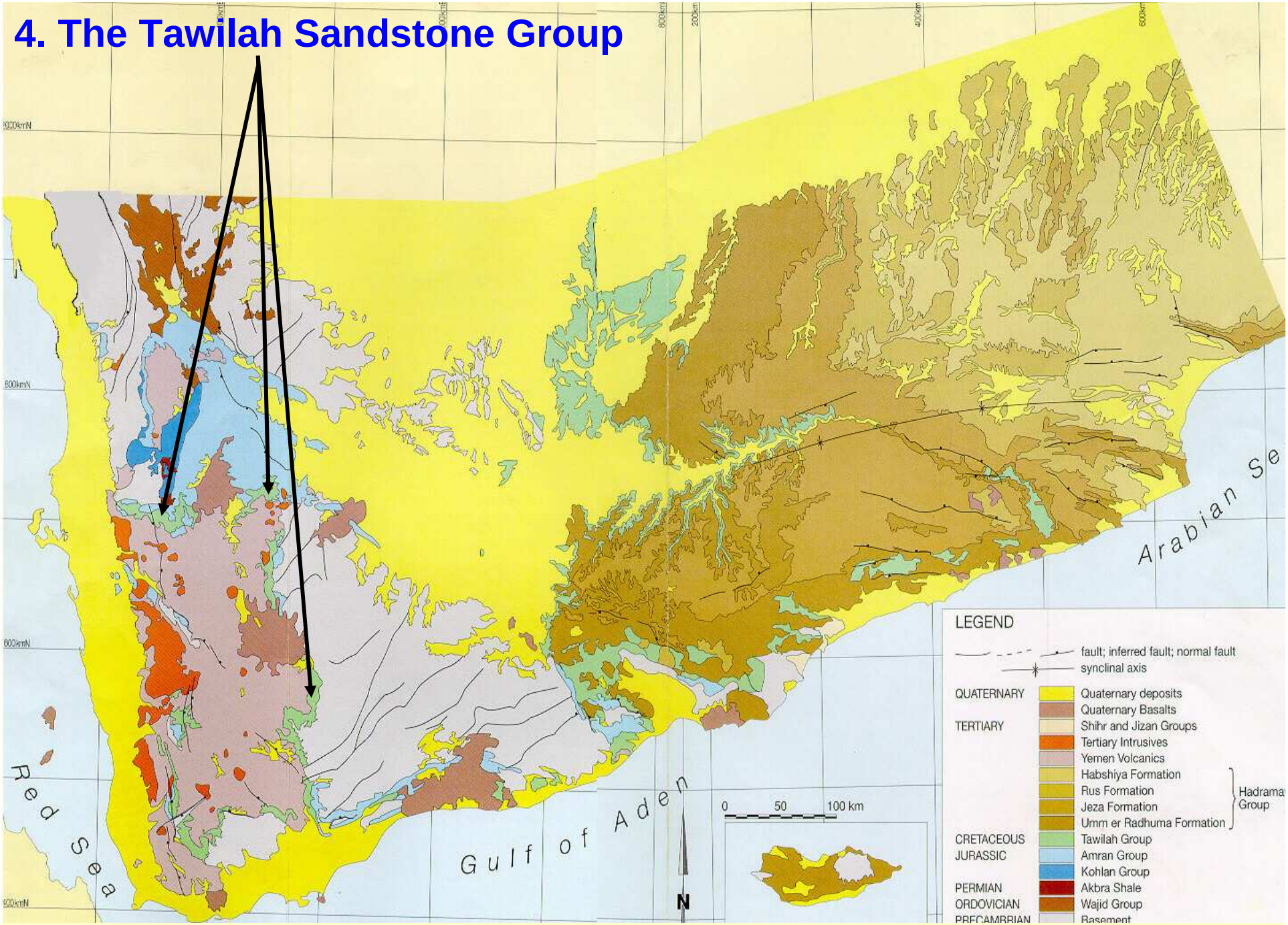
Locality: Salt domes of Shabwa area, West of Hadramout

Thickness: 300 m.

Rock types: Evaporites and clastic sediments rocks

Age: upper Jurassic

4. The Tawilah Sandstone Group



4. The Tawilah Sandstone Group

- **It has a wide geographic distribution**
- **It is composed mainly of sandstone**

Definition: Defined by many workers,
(Al-Nakhal, Al-Subary, 1994 etc)

Locality: Tawilah town, NW of Sana'a

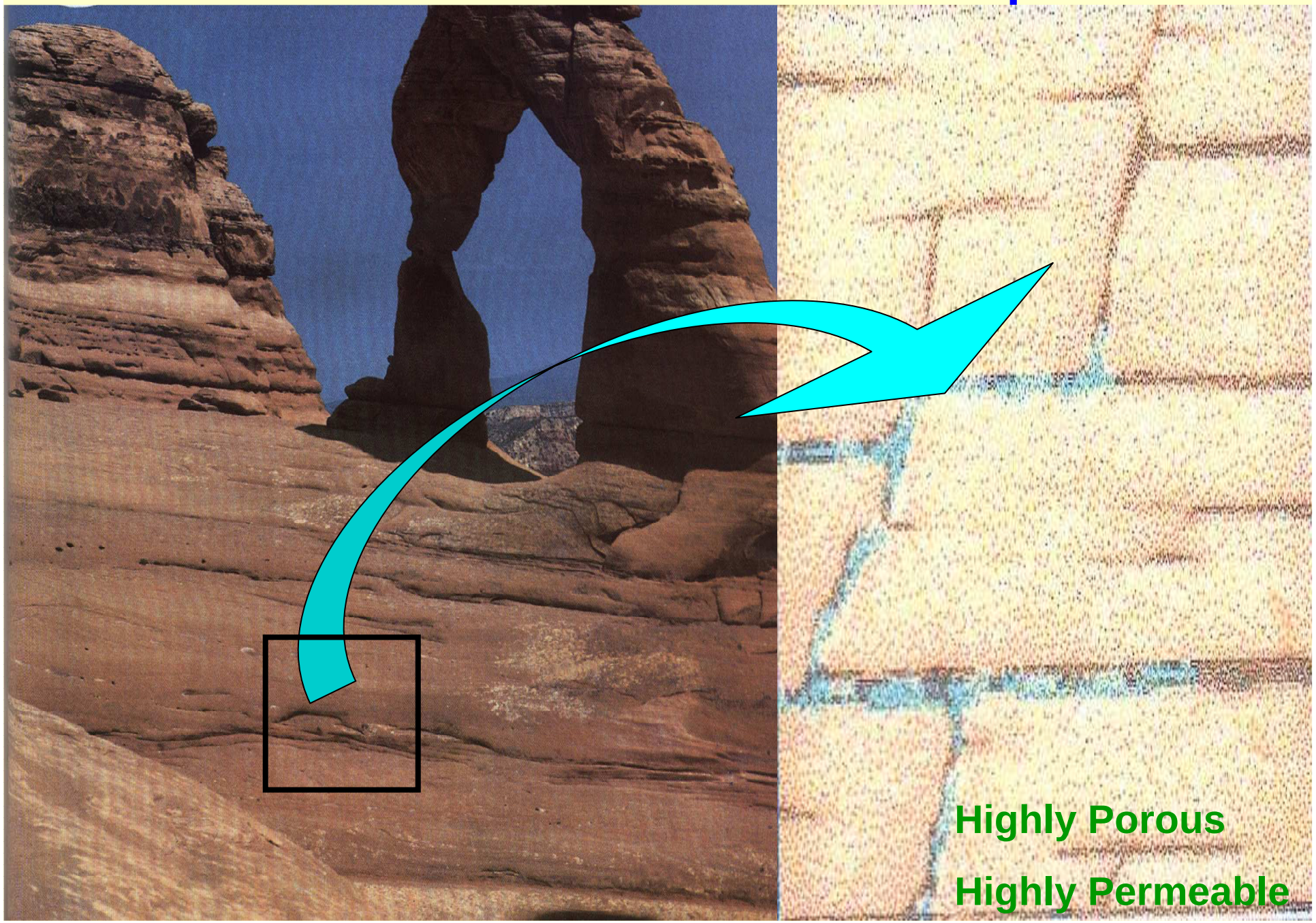
Thickness: 400 m

Rock types: non-fossilifrous porous & fissured sandstones

Origin: Fluvial deposits

Age: Cretaceous

Cretaceous Tawilah Sandstone Aquifer



5. The Mahra Group

Definition: Defined by Wetzel and Moton, (1948)
Locality: Al-Mahra area
Thickness: 849 m, *measured at Wadi Al-Masila*
Rock types: Carbonate rocks

Age: Lower Cretaceous

- It is located in the eastern part and laterally equivalent to Tawilah group
- it divided into five formations (from older to younger):

1. **Qishn Formation** (Limestone and Marl)
2. **Harshiyat Formation** (Clastic sediments)
3. **Fartaq Formation** (Limestone and shale)
4. **Mukalla Formation** (The most hydrogeologically prominent member of this group)
5. **Sharwayn** (Marly Limestone)

IV. CENOZOIC Rocks (Tertiary & Quaternary)

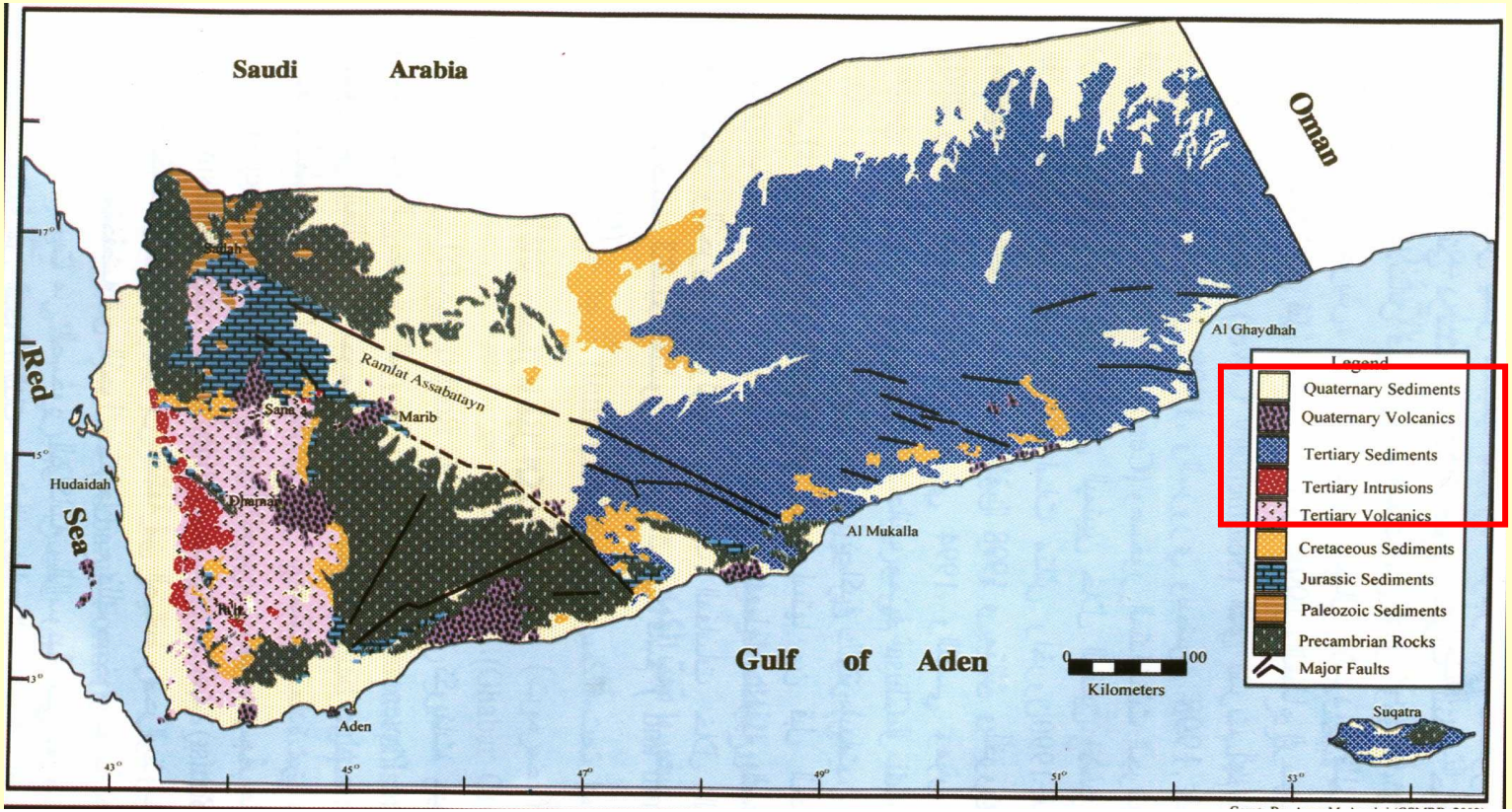
The Cenozoic sedimentary rocks cover almost the entire Arabian Shelf

I.e. (Eastern Part o Yemen)

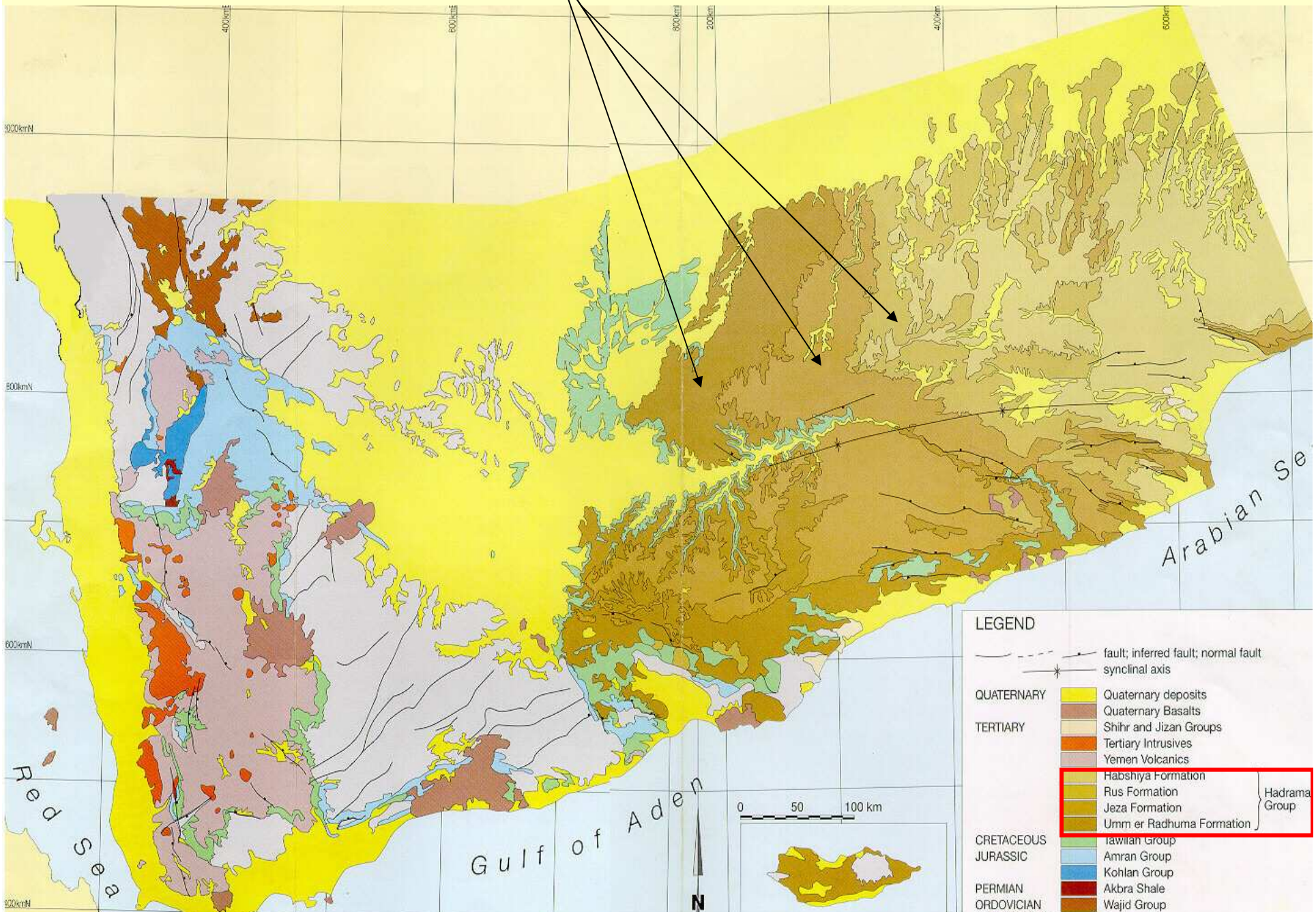
While

the western part of Yemen,

was extensively covered by basalts and other volcanic that make up the Yemen volcanic Group.



1. The Hadramout Limestone Group



1. The Hadramout Limestone Group

- It form an extensive and almost continuous cover in the eastern half of Yemen.

- The group is present over the Cretaceous Tawilah Group

Definition: 1st Defined by Wetzel and Morton, (1948)
Locality: Southern part of Yemen

Thickness: Maxim. Exposed thickness in Wadi Al-Masila is 818 m.

Rock types: Carbonates and Evaporites.

Origin: Marine deposits
Age: Lower Tertiary

It has been divided (from older to Younger) into four formations:

1. Umm-Er-Radhuma Formation: The lateral equivalent of this forrmation in western Yemen is the Medj-zir Sandstone formation

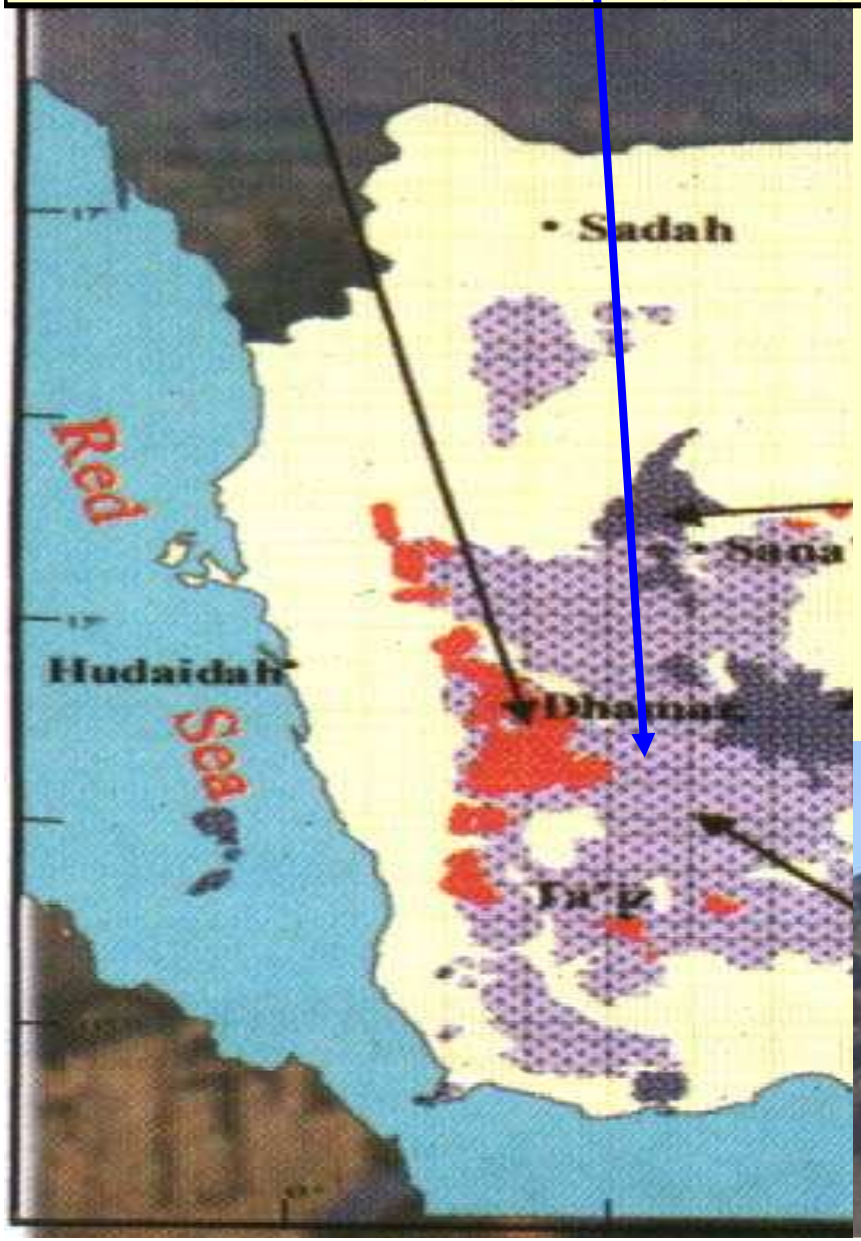
2. Jeza Formation: well bedded limestone

3. Rus Formation: Gypsum and anhydrites, dolomitic limestone and

4. Habshiat Formation: limestone is dominant with thickness about 175 m.

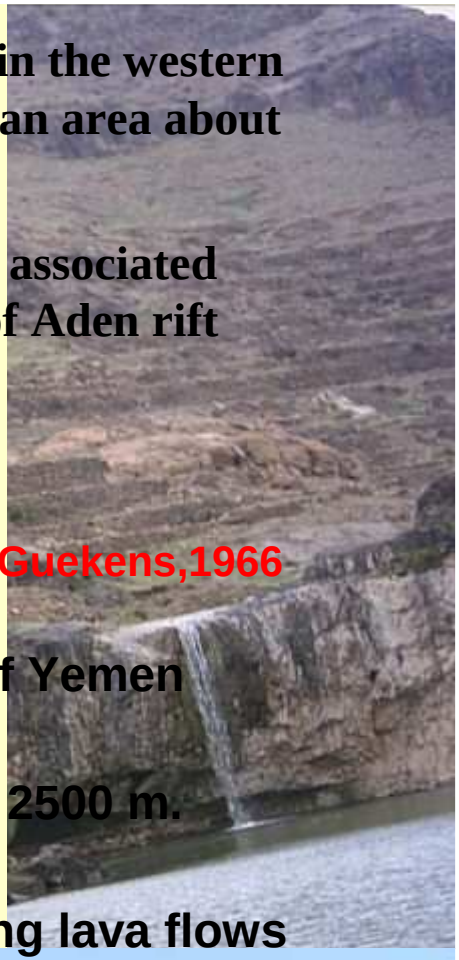
2. Tertiary Volcanics

Intrusive and Volcanic Rocks



- It forms continues plateau in the western part of Yemen covering an area about 50,000 km^2.

- The volcanism activity was associated with Red Sea and Gulf of Aden rift systems (20 – 31 My).



Definition: 1st Defined by Guekens,1966

Locality: Western part of Yemen

Thickness: may exceed 2500 m.

Rock types: alternating lava flows

Age: Tertiary

3. Miocene Salif Evaporites "Baid formation "

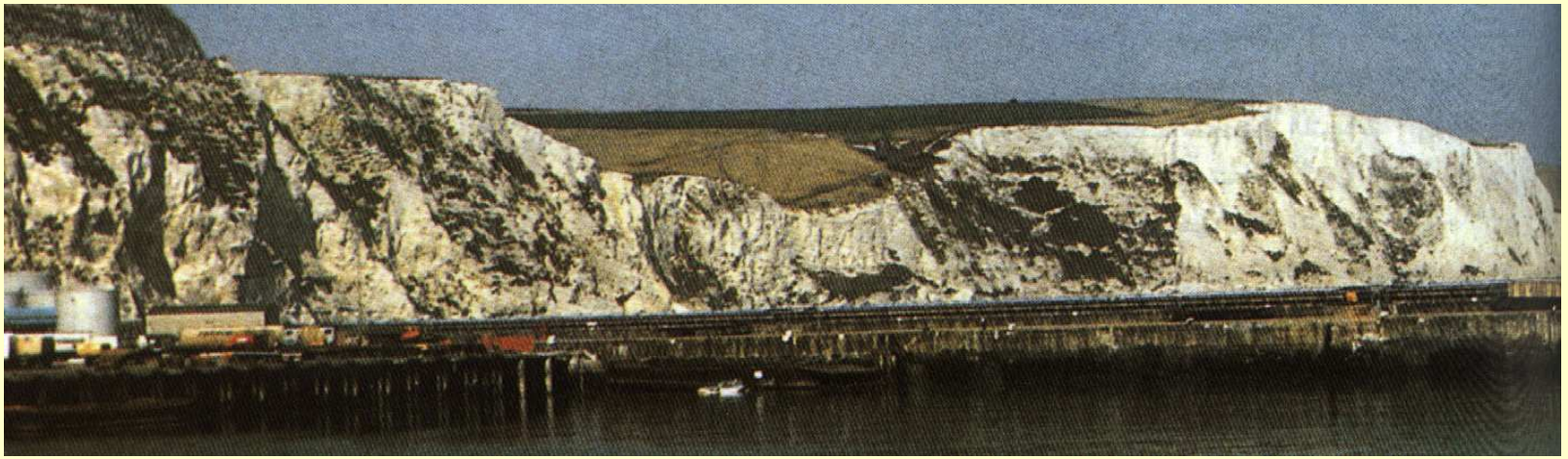
-These deposits occur along the Arabian side of the Red Sea.

- They were precipitated during the opening of the Rd Sea.

-They exposed as salt domes near Al-Salif, 70 km north of Al-Hudaidah and at Jabal Al-Milh, north of Al-Salif.

They consist mainly of halite, covered by gypsum.

- The total thickness of this formation is about several hundred of meters.



4. Shihr Group

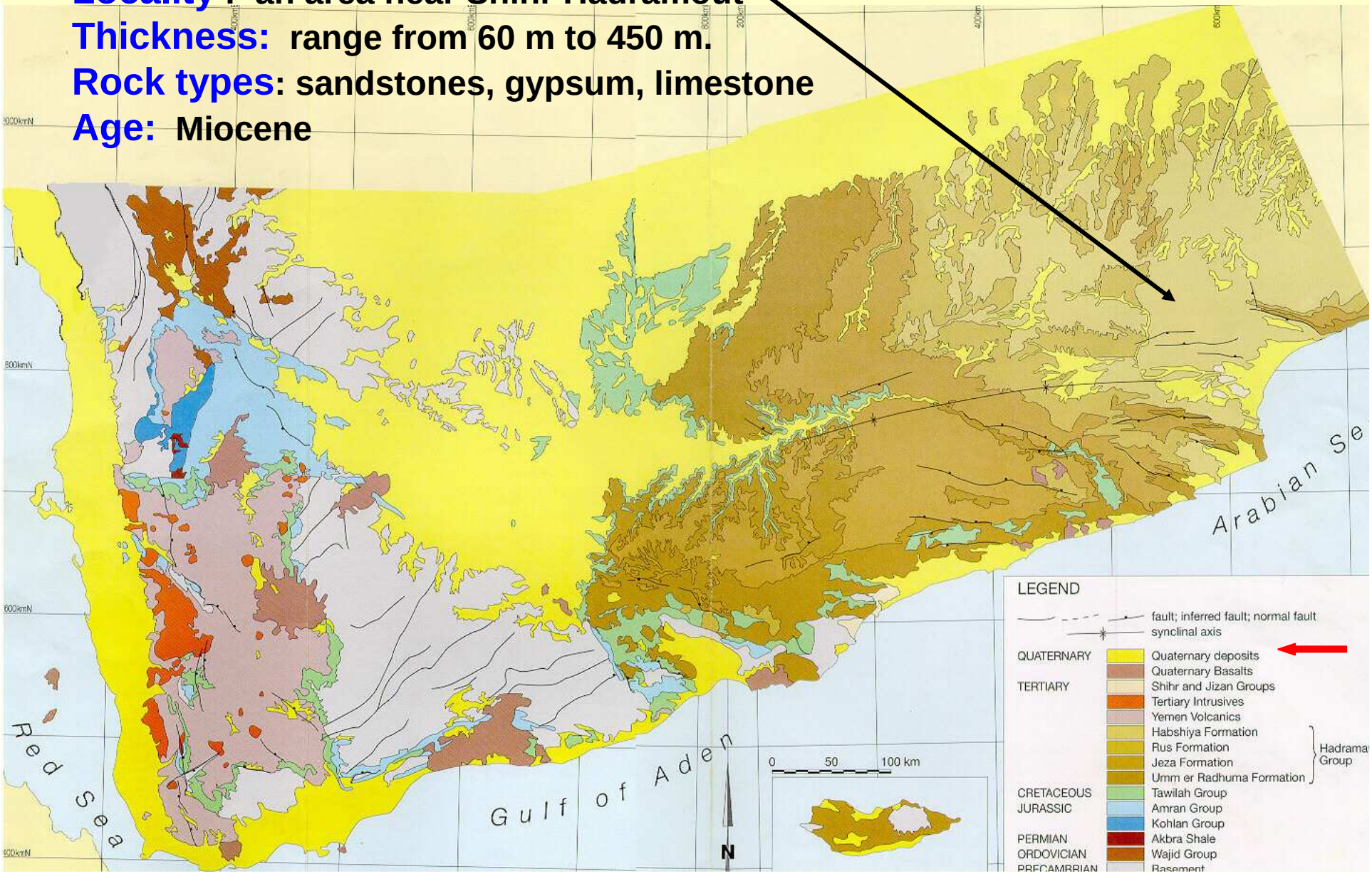
-Definition: 1st **Defined by Wetzel and Morton, (1948) and Beydoun (1964)**

Locality : an area near Shihr Hadramout

Thickness: range from 60 m to 450 m.

Rock types: sandstones, gypsum, limestone

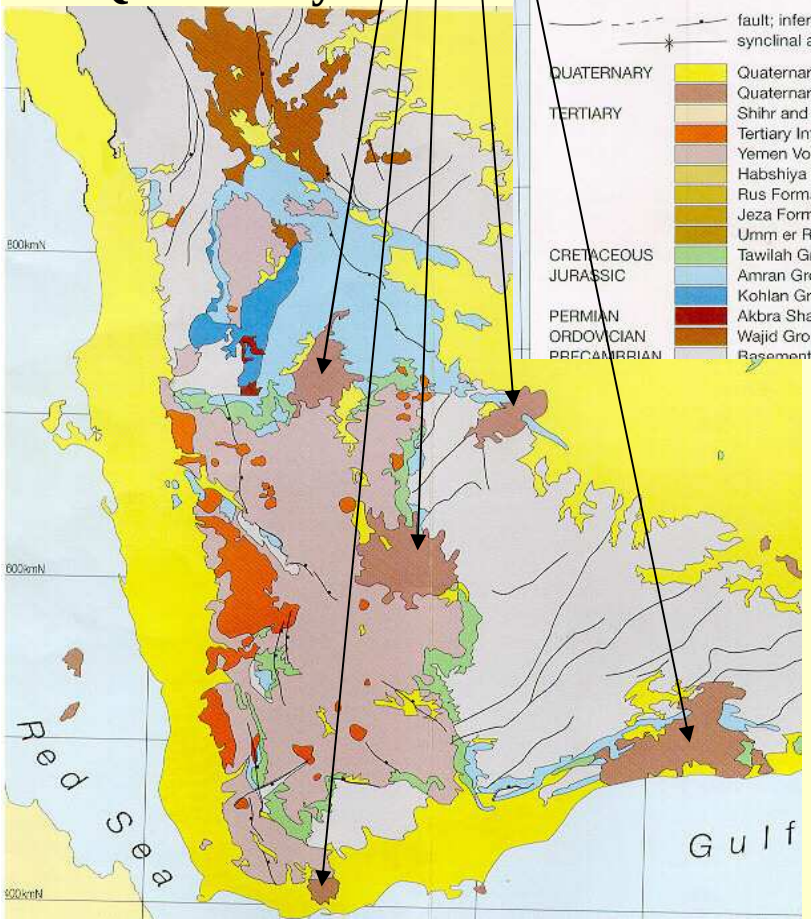
Age: Miocene

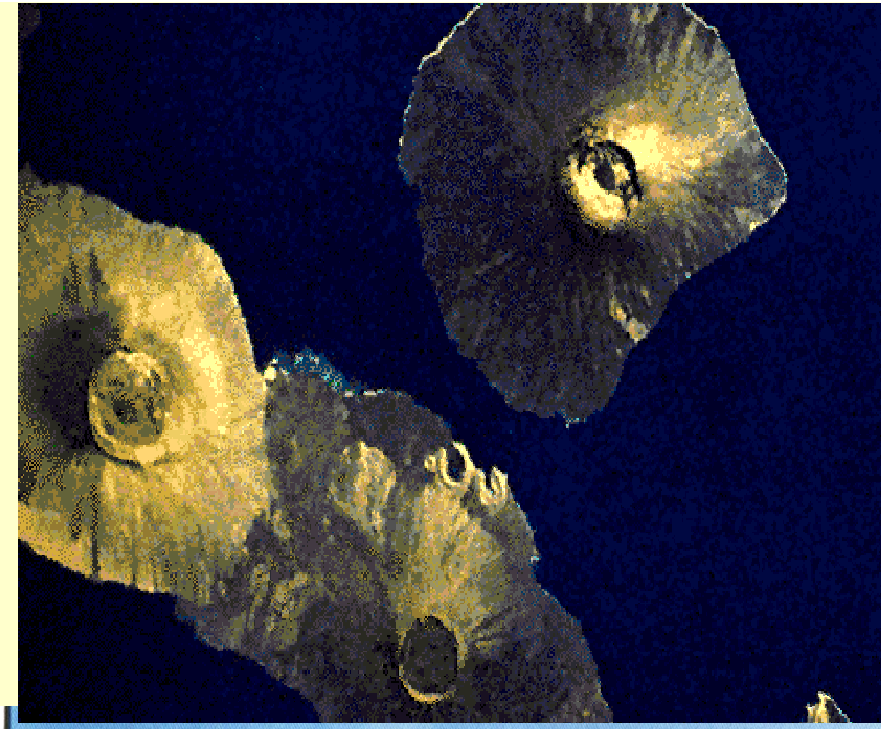


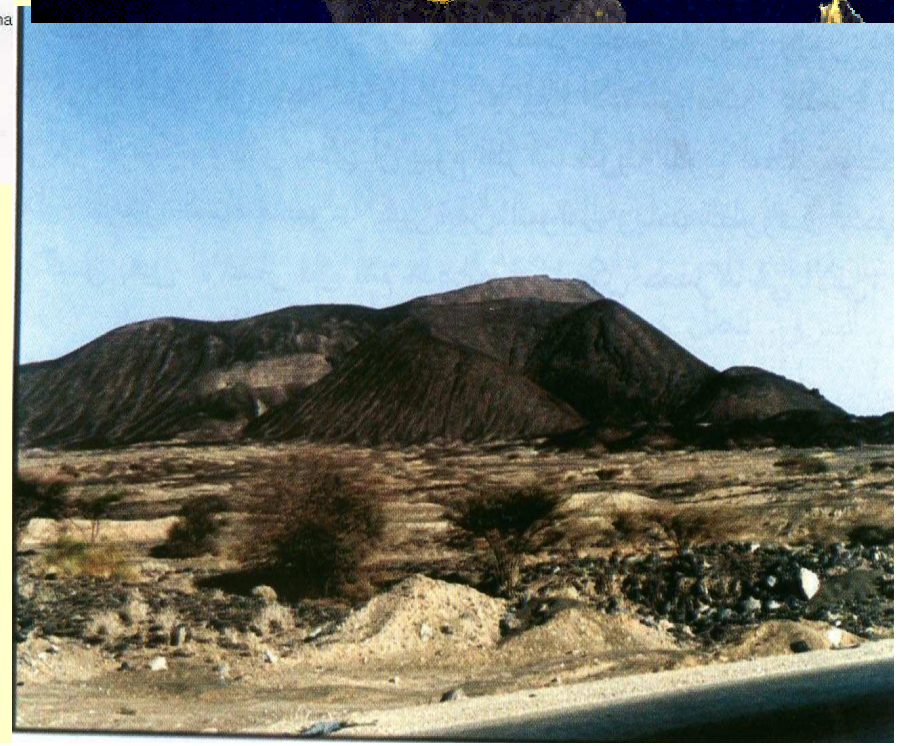
5. Quaternary Volcanics

- **These type of Volcanics have cone or crater morphology.**

- **There is a time gap of approximately 10 millions years between the eruption of Tertiary Yemen Volcanic and those of Quaternary basalts.**

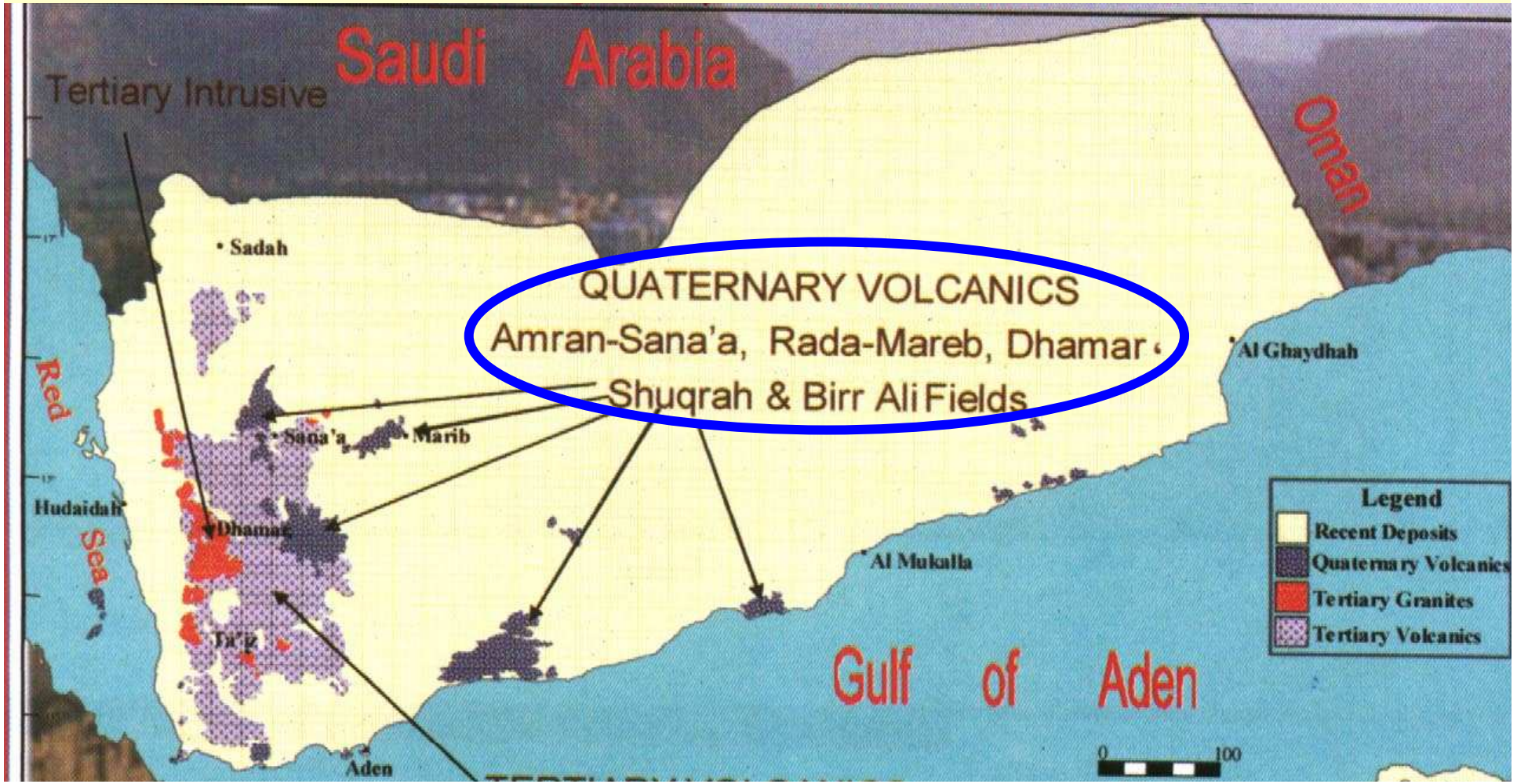






They Quaternary Volcanics are known in four main volcanic fields:

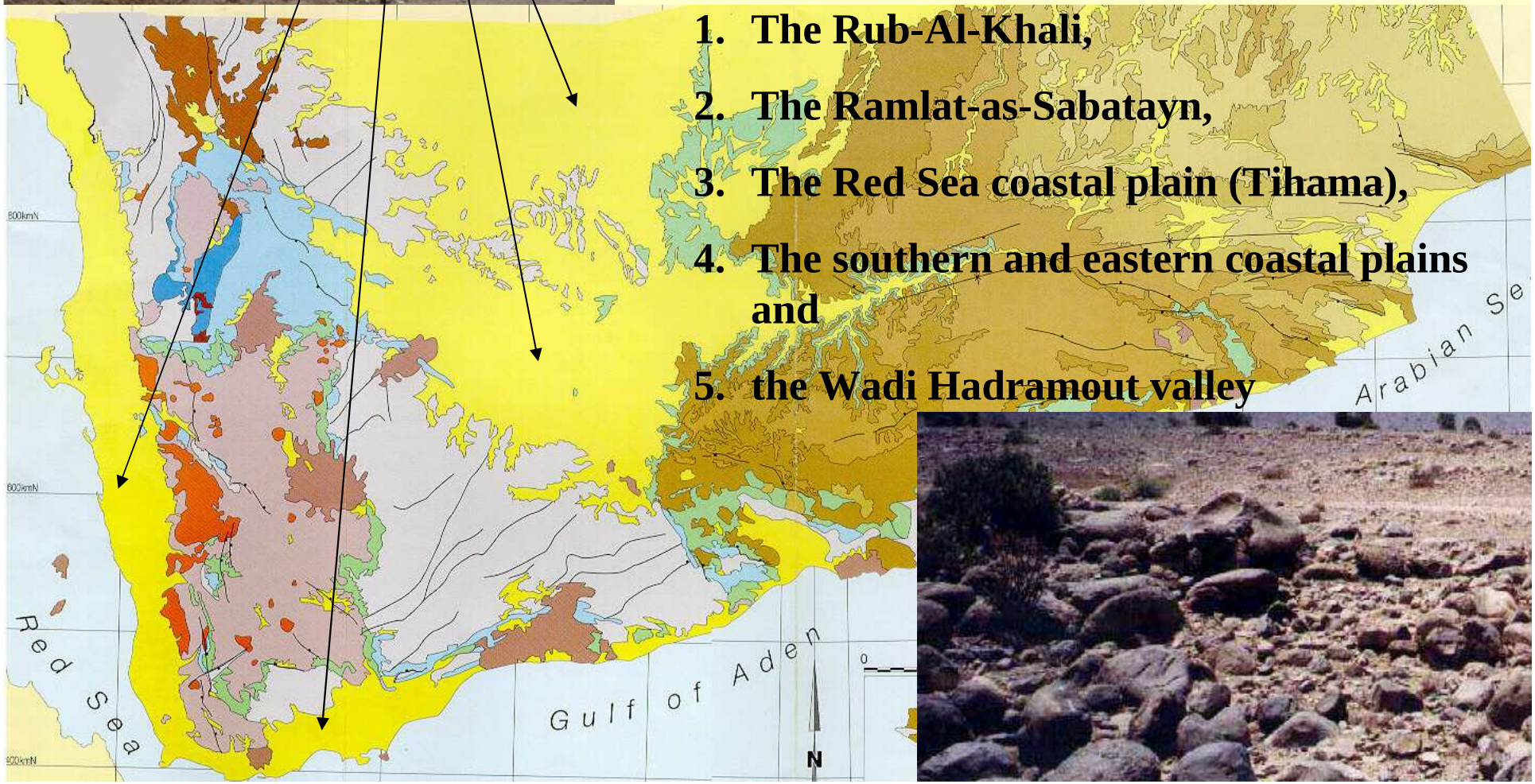
1. Amran-Sana'a **field**,
2. Rada – Marib **field,**
3. Dhamar **field** and
4. Aden and Shuqra – Bir Ali **fields.**



6. Quaternary alluvial Deposits

- These deposits are scattered widely over the country
- The thickness of these sediments are variable
- They are encountered in :

1. The Rub-Al-Khali,
2. The Ramlat-as-Sabatayn,
3. The Red Sea coastal plain (Tihama),
4. The southern and eastern coastal plains and
5. the Wadi Hadramout valley



Geological Structures

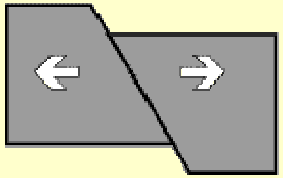
Type of Structures:

1. Joints and Fractures
2. Faults
3. Folds

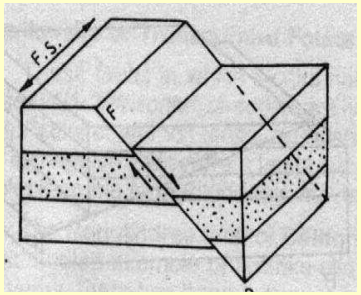
1. Joints and Fractures

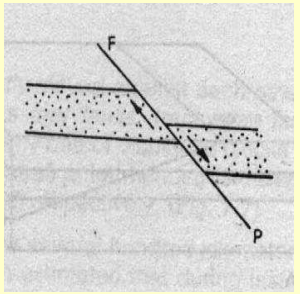
2. Faults

A. Normal Fault: "Gravitational fault

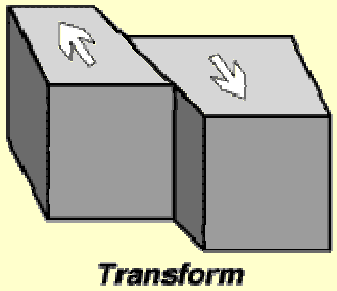


Extensional

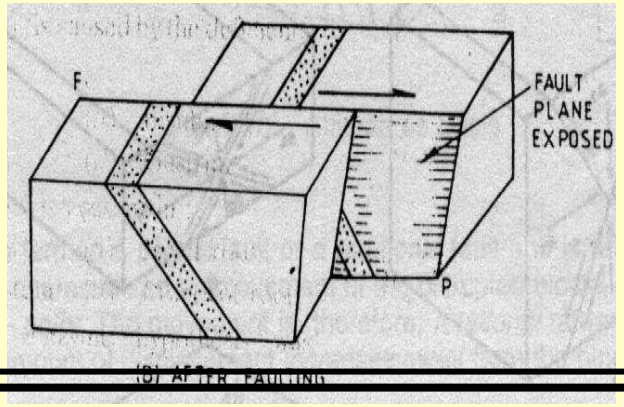




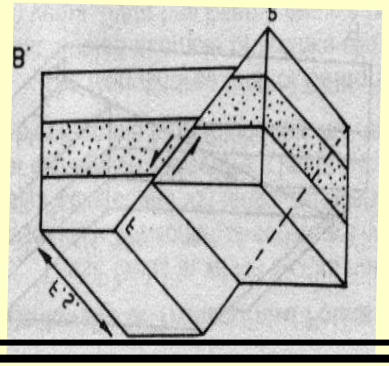
B. Horizontal Fault: Transform Fault

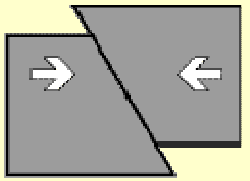


Transform



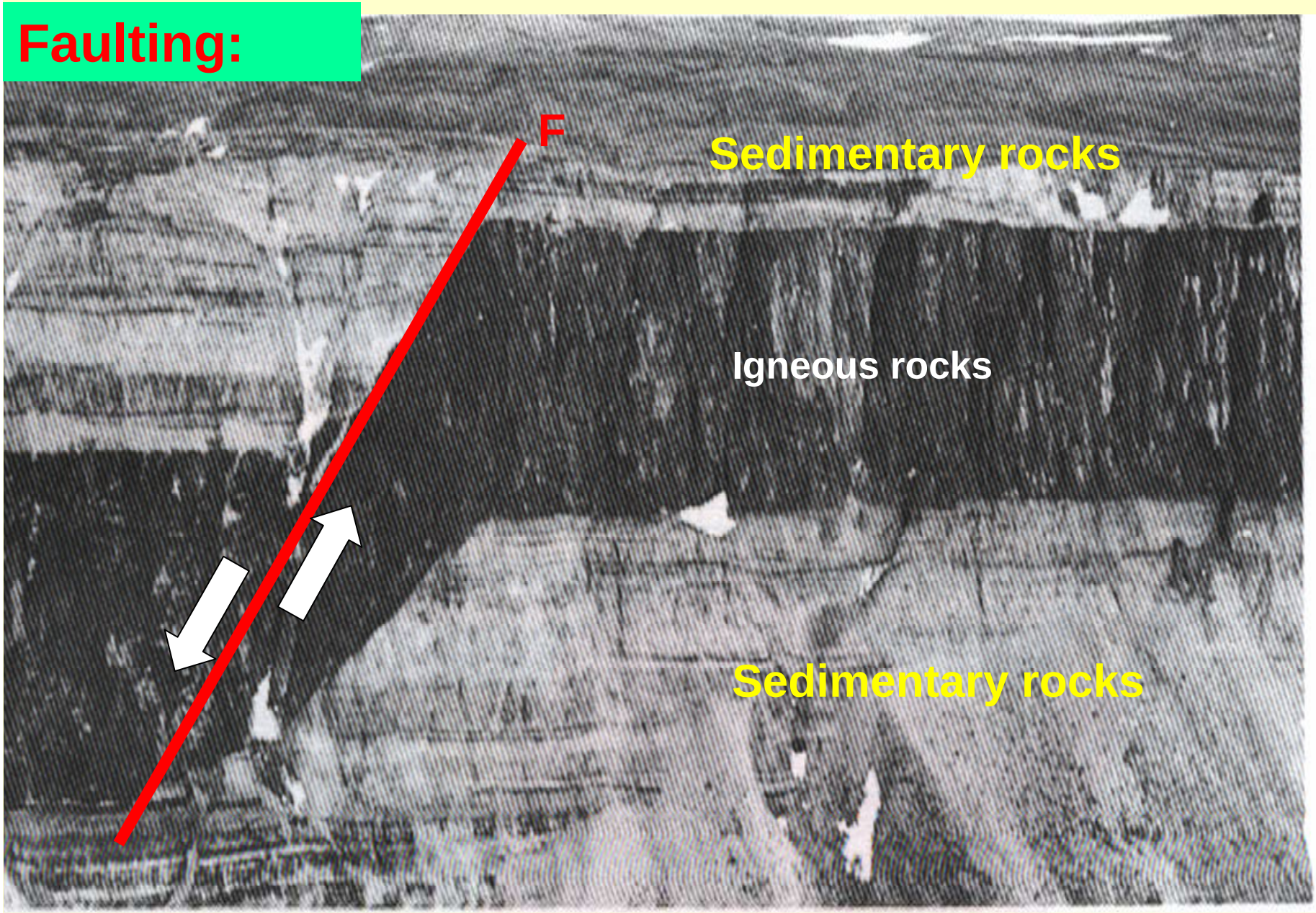
C. Reverse: Thrust Fault

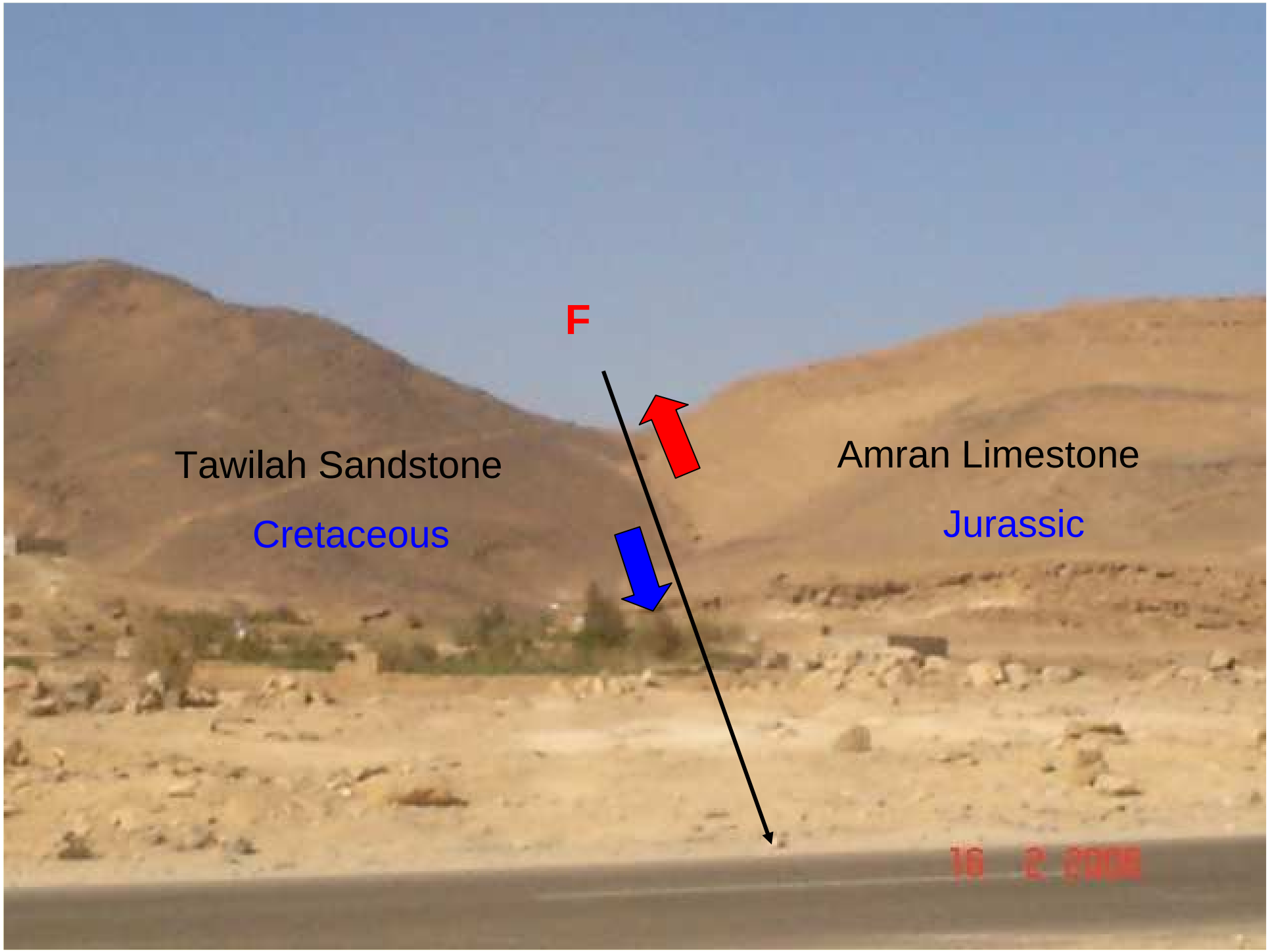




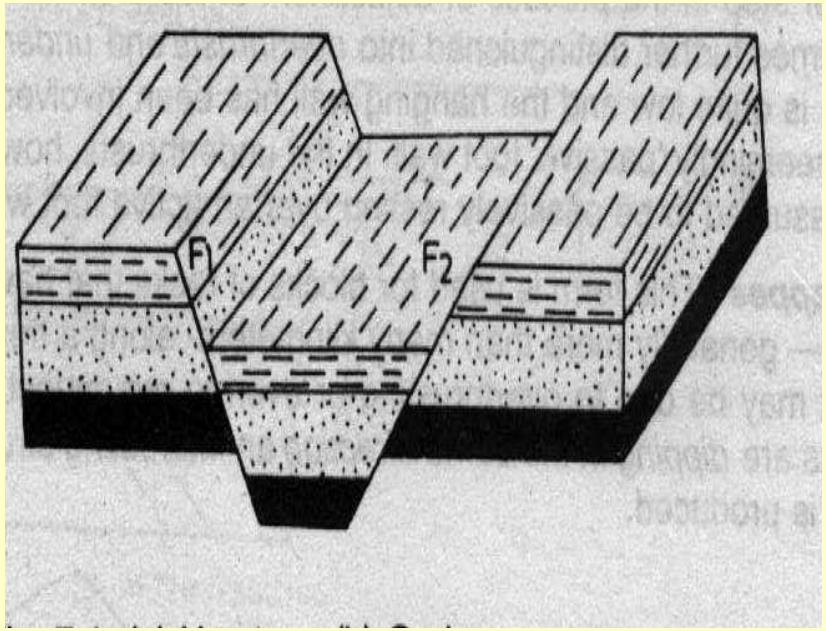
Compressional

Faulting:

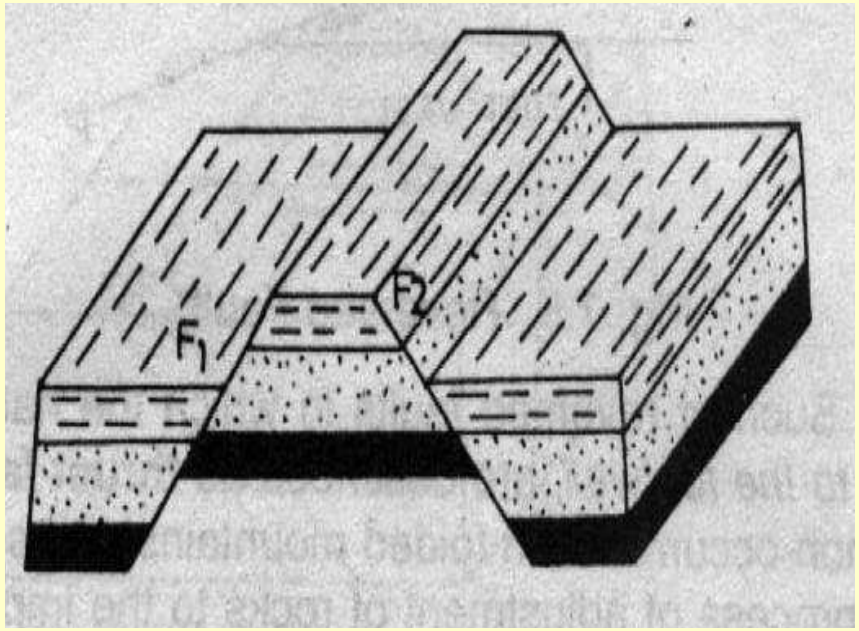


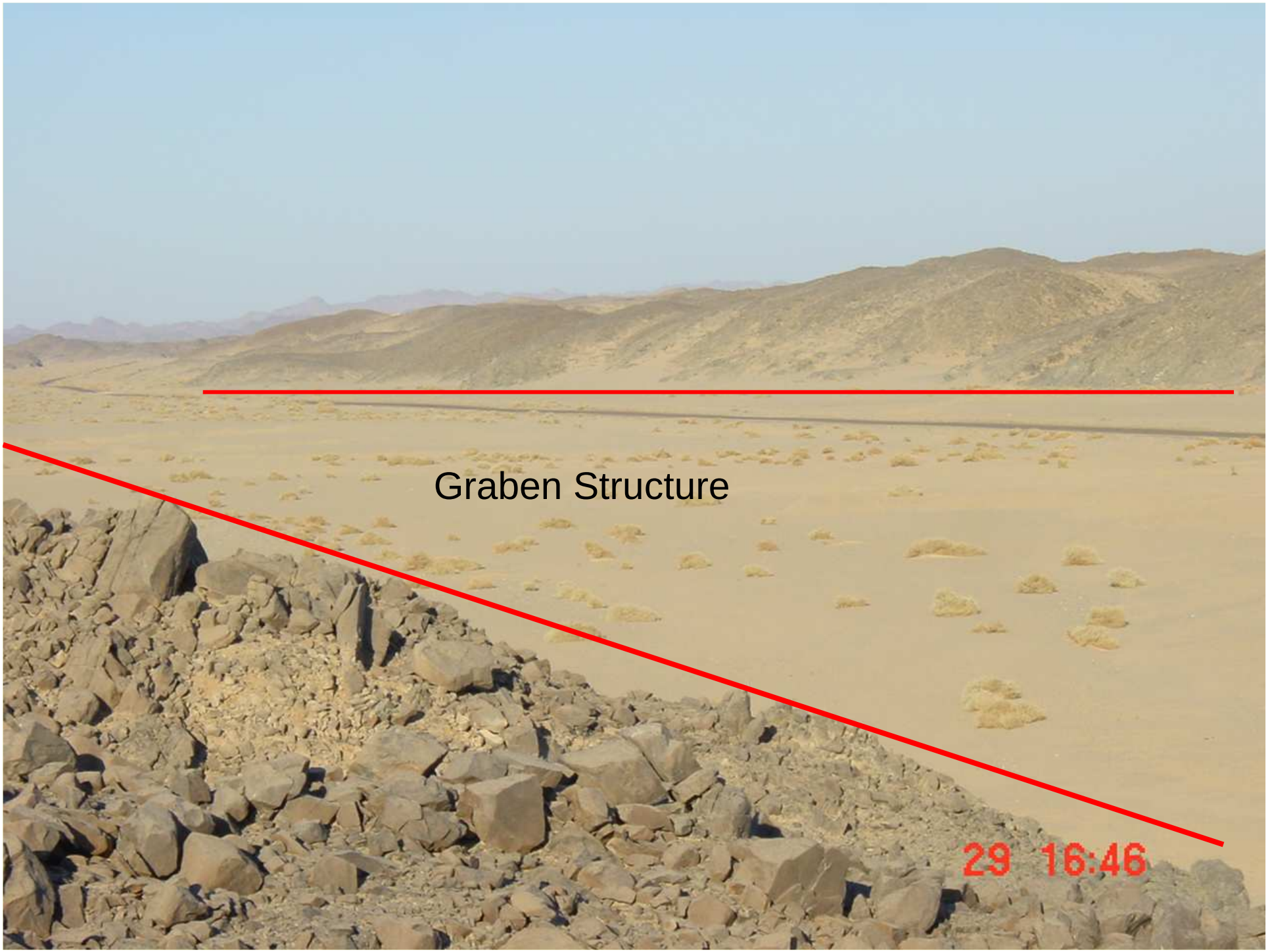

F
Tawilah Sandstone
Cretaceous
Amran Limestone
Jurassic

Graben Structure



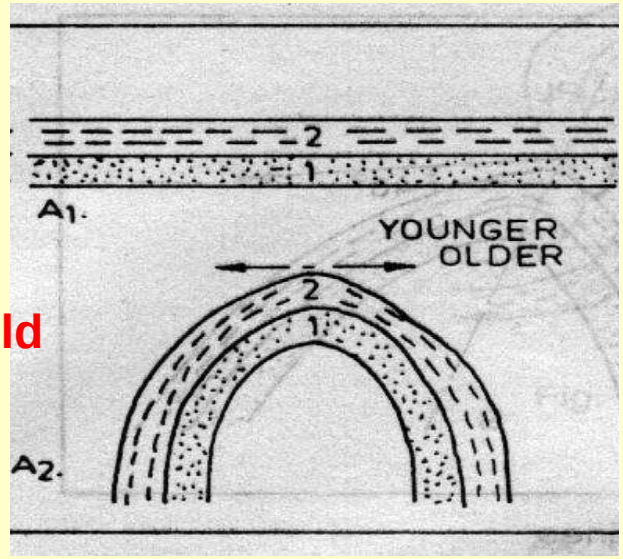
Horest Structure

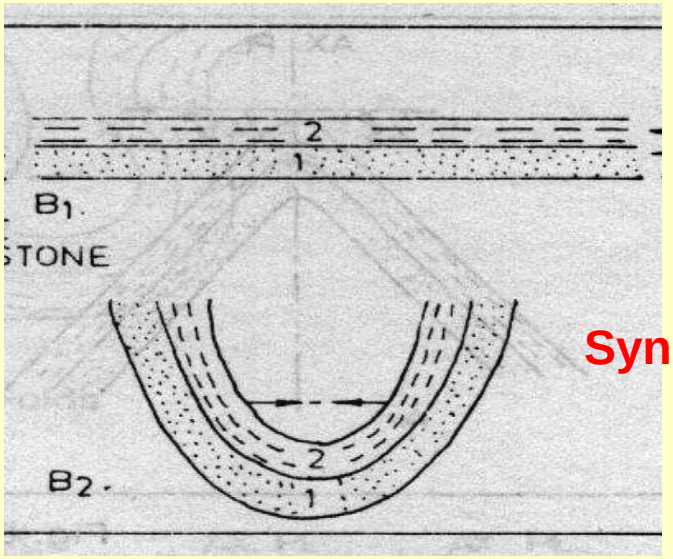



Graben Structure
29 16:46

3. Folds:

Anticline Fold



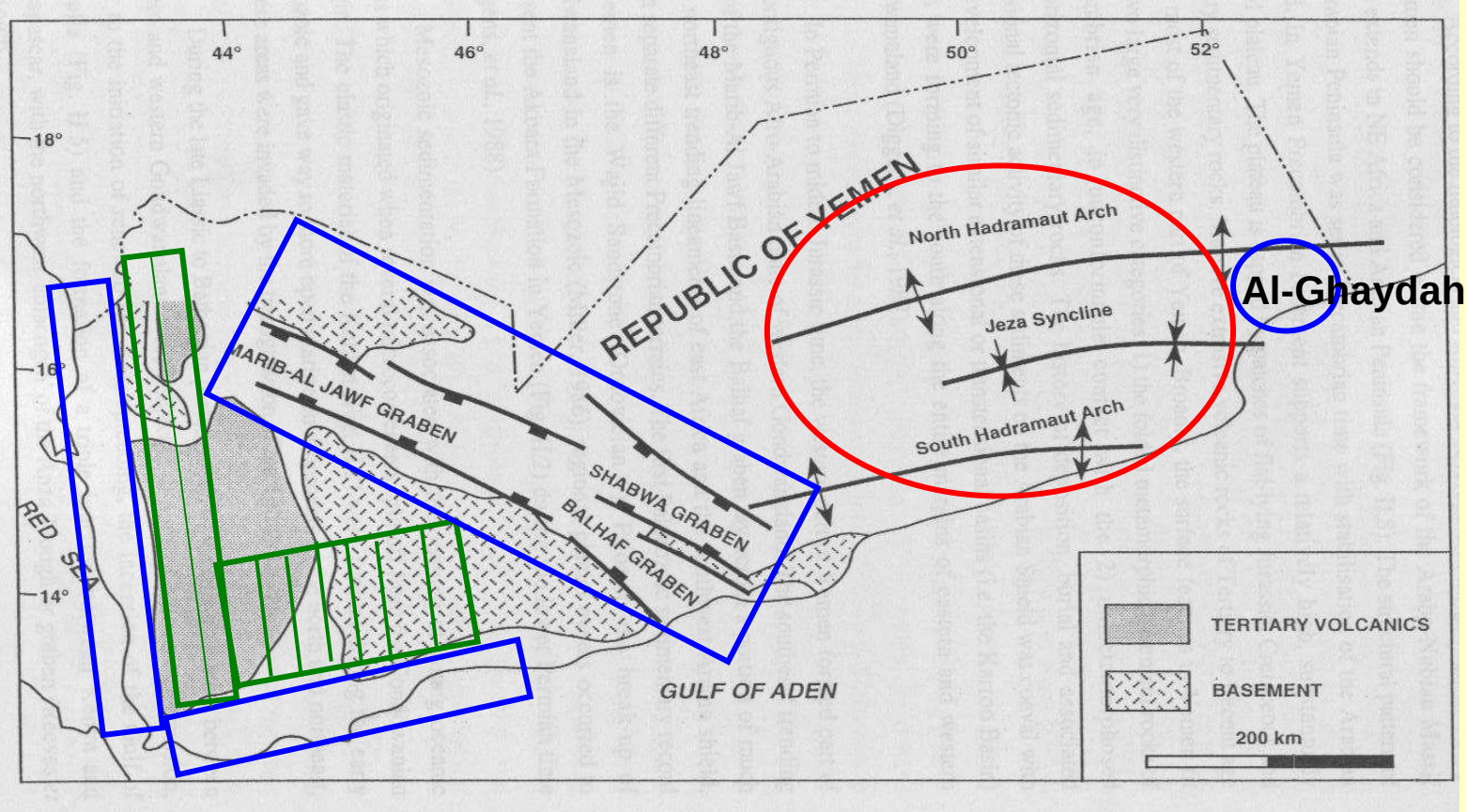


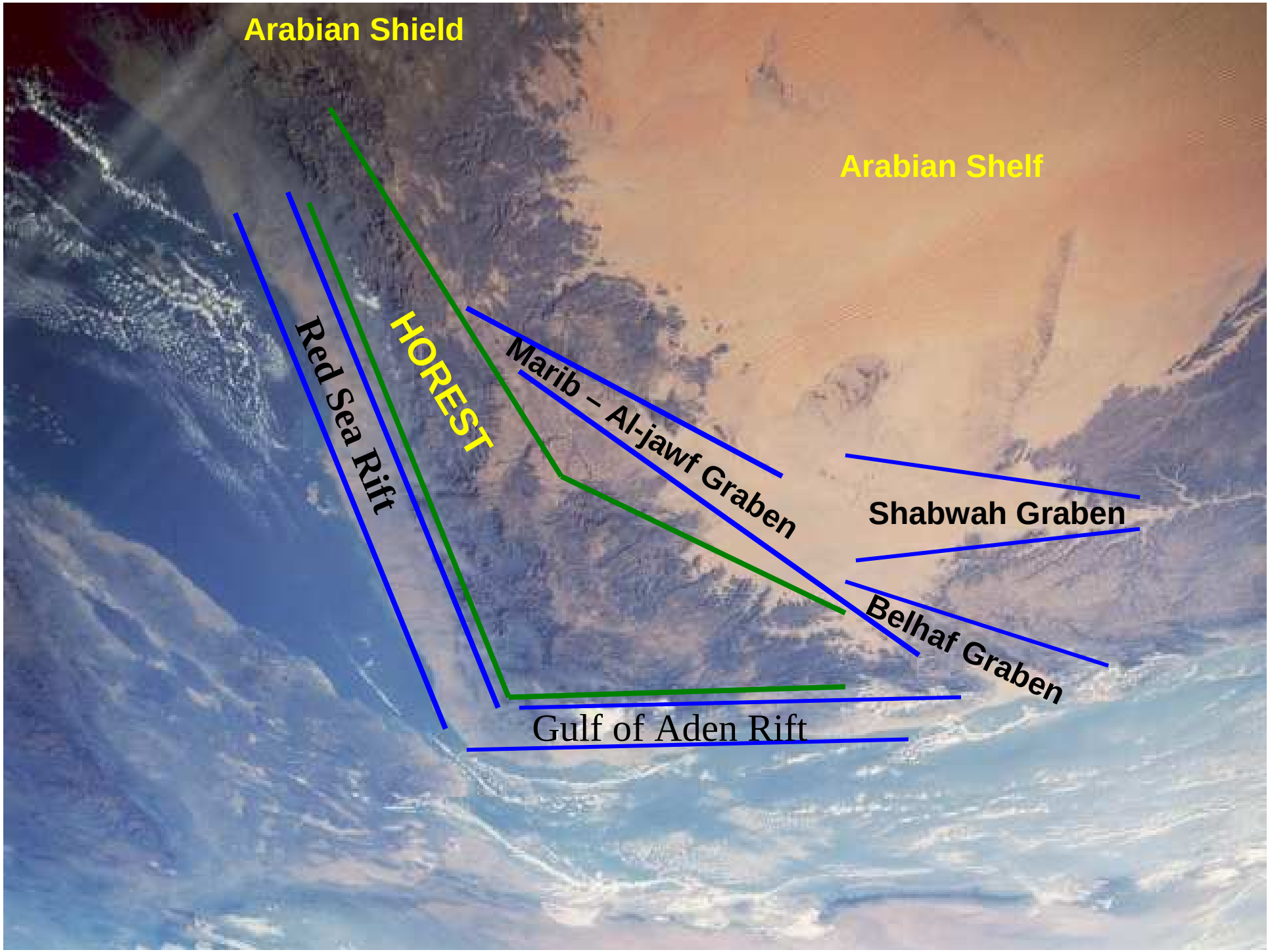
Syncline Fold

Structural History of Yemen:

The overall geological stricture of Yemen is dominated by:

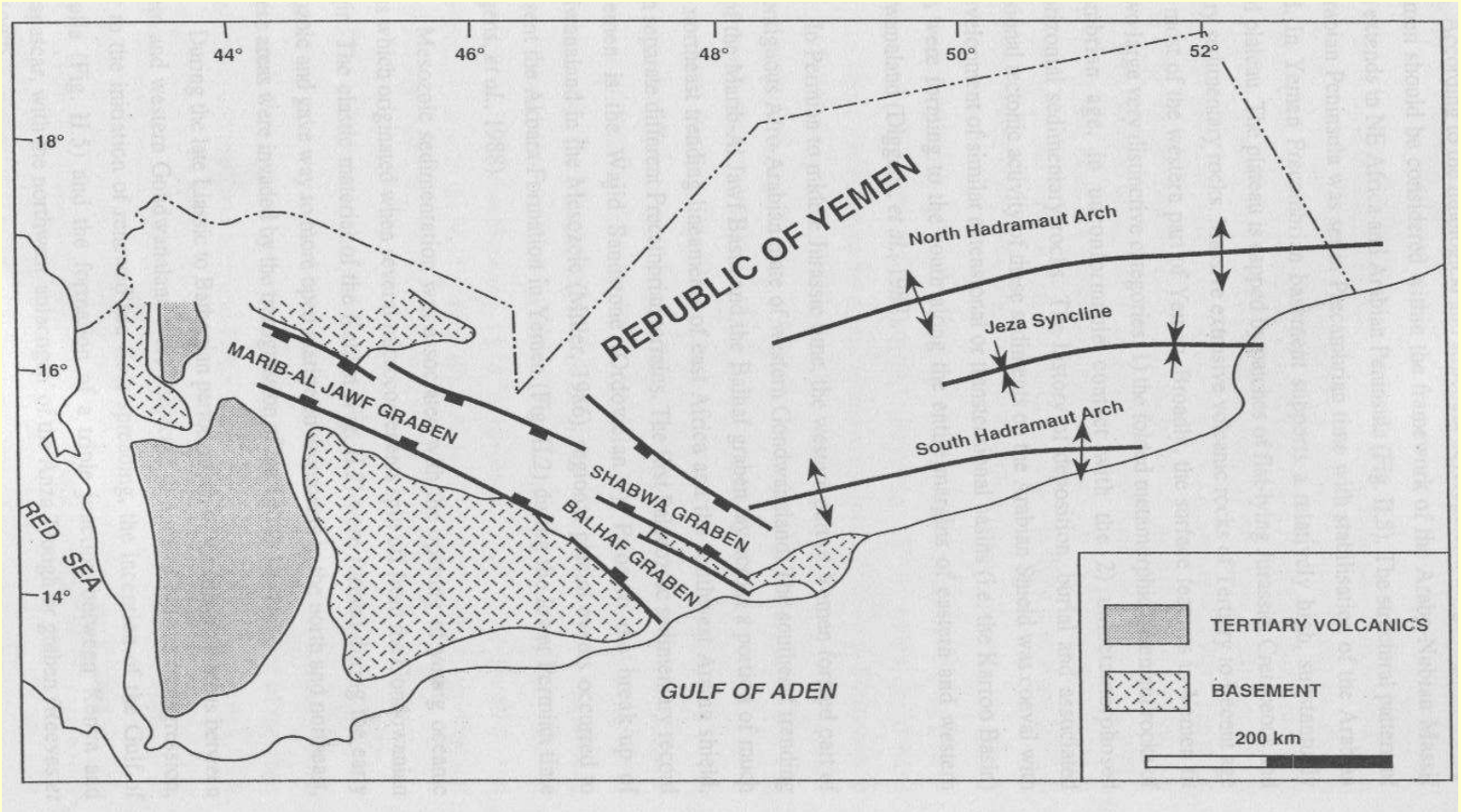
1. **The uplifted Arabian Shield (Yemen Horst)**
2. **Southern and Northern Hadramout Arches (Anticlinals)**
3. **The rift valleys of:** **a. Red Sea and Gulf of Aden**
   b. Sadah – A-Jawf – Balhaf graben system and
   c. Al-Ghaydah Depression




Arabian Shield
Arabian Shelf
Red Sea Rift
HOREST
Marib – Al-jawf Graben
Shabwah Graben
Belhaf Graben
Gulf of Aden Rift

A. Rifting of the Marib-Al-Jawf Basin:

- It is known as the Ramlat-as-Sabatayn Graben
- It has a total length of 650 km and up to 100 km wide
- It is parallel to Najd Fault System in Saudi Arabia
- It has a high economic interest because of its petroleum potential



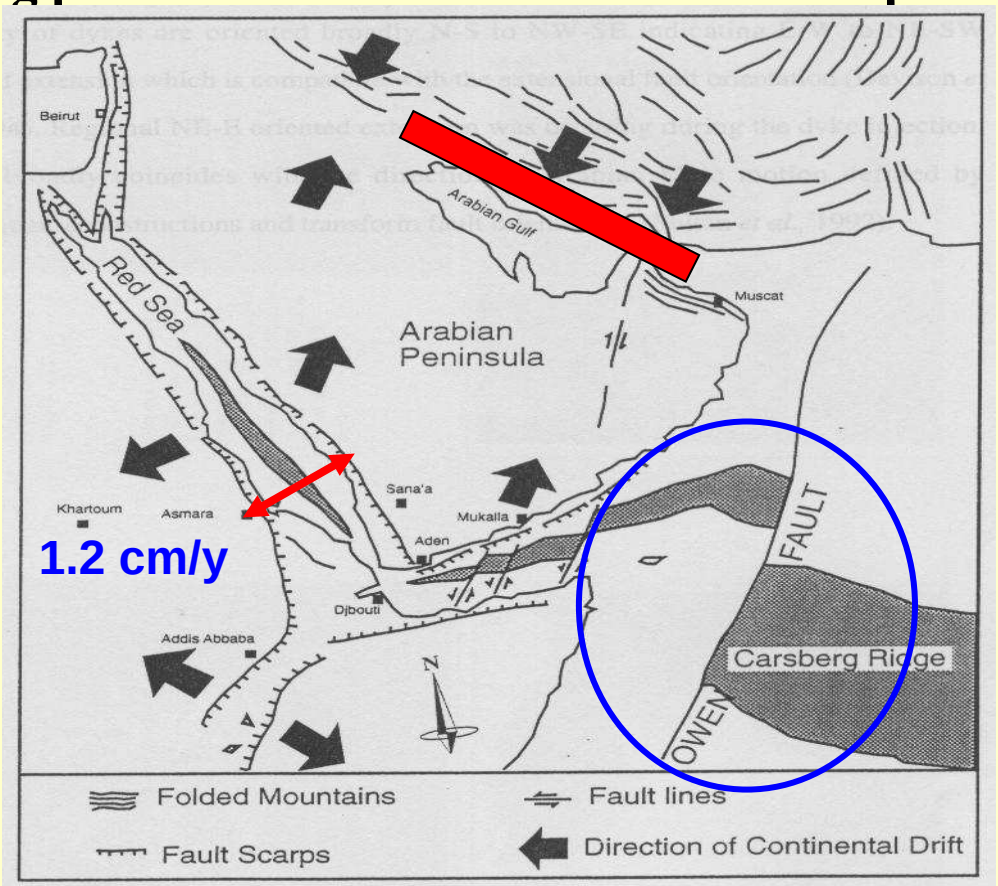
B. The rift of the Red Sea and Gulf of Aden:

- The Arabia and Africa were representing one continental block, Till Mesozoic and early Cenozoic

- The separation of Arabia from Africa started in the middle Miocene (20 – 31 Ma)

- Today the plate tectonics of the Arabian Plate are dominated by NE movement of the Arabian Plate (1.2 cm/yr) away from African Plate.

- A collision is taking place between Arabian and Iranian plate forming Zagrous mountains




The End