The Palaeotethys Suture Zone in NE Iran: New Constraints on the Evolution of the Eo-Cimmerian Belt (Darius Programme)*

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Abstract

North Iran is a key-area for the Cimmerian orogeny, which is related to the Late Triassic collision of Iran with Eurasia and to the closure of the Palaeotethys. Recent analyses of the Cimmerian evolution have been performed on the Alborz, whereas studies in NE Iran are rare. Due to the importance of this region for the reconstruction of the Cimmerian event, a research project sponsored by the Darius Programme has been focused on the area east of Mashad (Fariman). Here, the occurrence of a thick succession of Permian andesitic to basaltic submarine lava flows interfingering with shallow-water limestones and silicilastics raise several questions on the geodynamic significance of this peculiar rock association, previously interpreted as a Palaeotethys-related accretionary wedge. Problematic are also the Permian "ophiolites" of Darreh Anjir, which do not seem to represent typical oceanic crust remnants.

Detailed studies of this succession allowed us to substantially modify previous interpretations. The Permian units were deposited in a marine basin close to a volcanic area, where a large volume of lava flows was emplaced in submarine conditions. Deformational features are not typical of an accretionary wedge as neither disruption of the stratigraphy nor penetrative shear zones and HP metamorphism have been found. Geochemical data suggest an arc-related setting developed on a continental crust. We thus interpret these units as remnants of a supra-subduction arc-related complex, grown during the Permian along the active Eurasian margin above a north-dipping subduction zone, where the Palaeotethys ocean was consumed.

North of this area, the intra-arc basin of Aghdarband records the Triassic history of the collision zone. The Triassic successions show a north-verging Cimmerian imbricate thrust fan developed in a retro-wedge position with respect to the main north-dipping collision zone located south of Mashad. The thrust fan interacts with a major ESE-WSW left-lateral fault zone, accommodating an important component of oblique convergence. All these structures are sealed by the Bajocian Kashaf Rud Formation, indicating that the main deformation, affecting also Upper Triassic units, can be related to the Cimmerian events.

These new data add important information on the evolution of the pre Middle Jurassic history of the basement of the hydrocarbon-rich Kopeh Dagh Mesozoic and Tertiary successions which are exposed in NE Iran and Turkmenistan.

References

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The Palaeotethys suture zone in NE Iran: new constraints on the evolution of the Eo-Cimmerian belt (Darius Programme)

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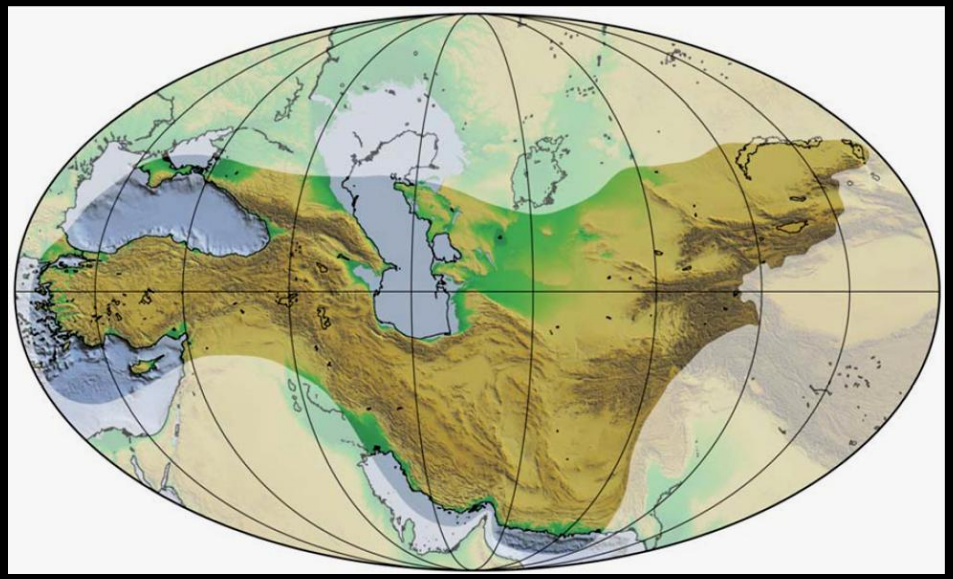
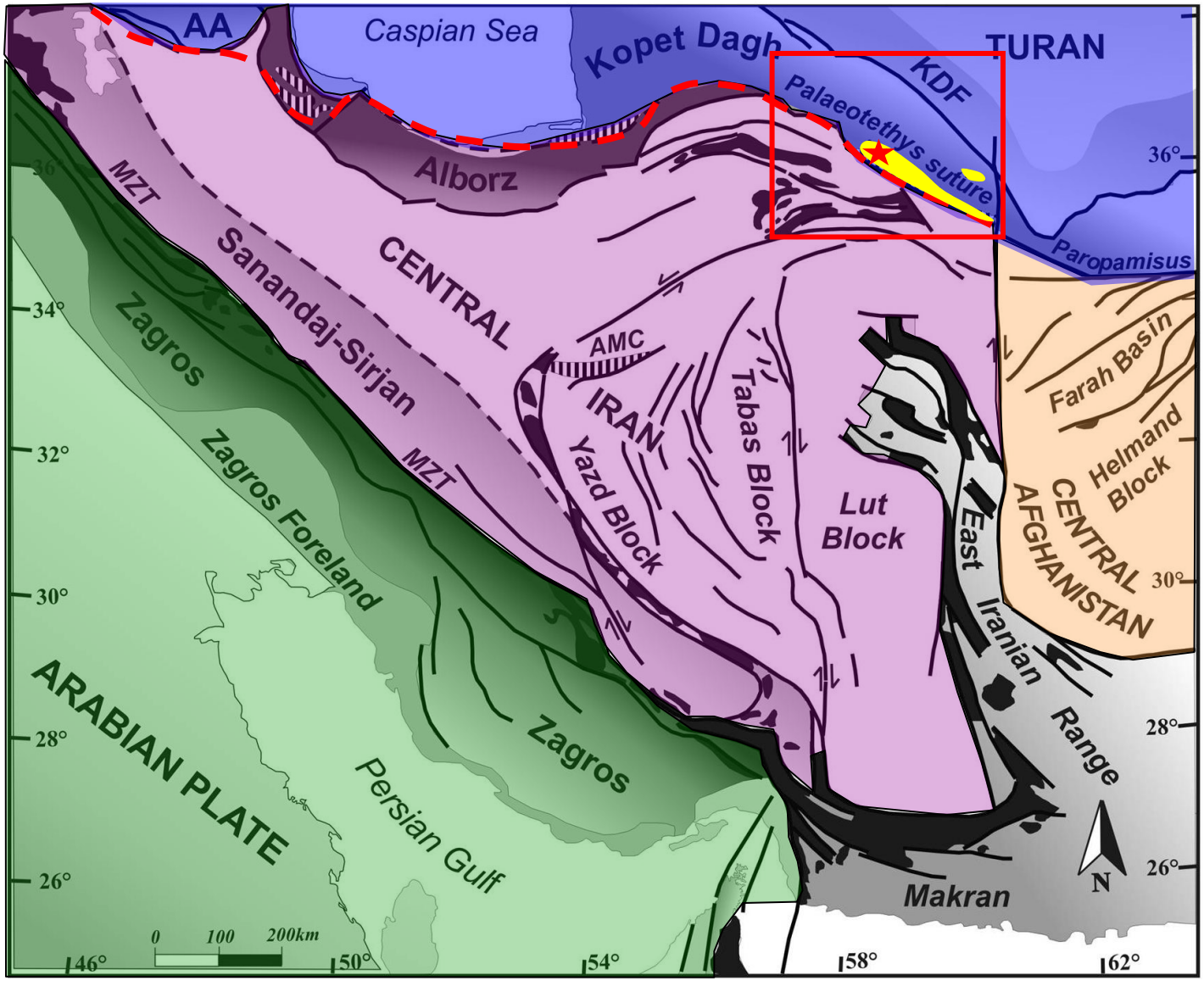
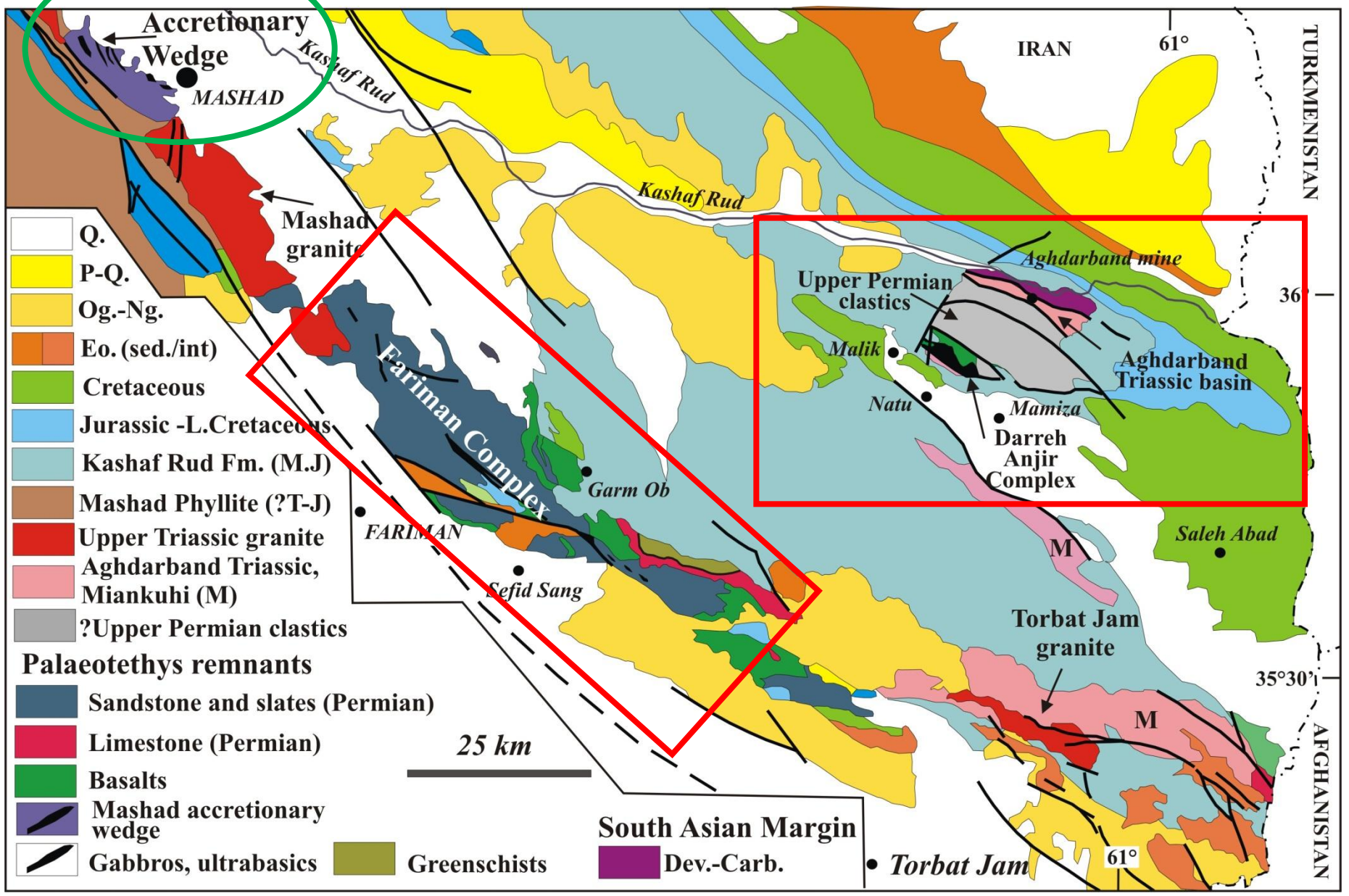
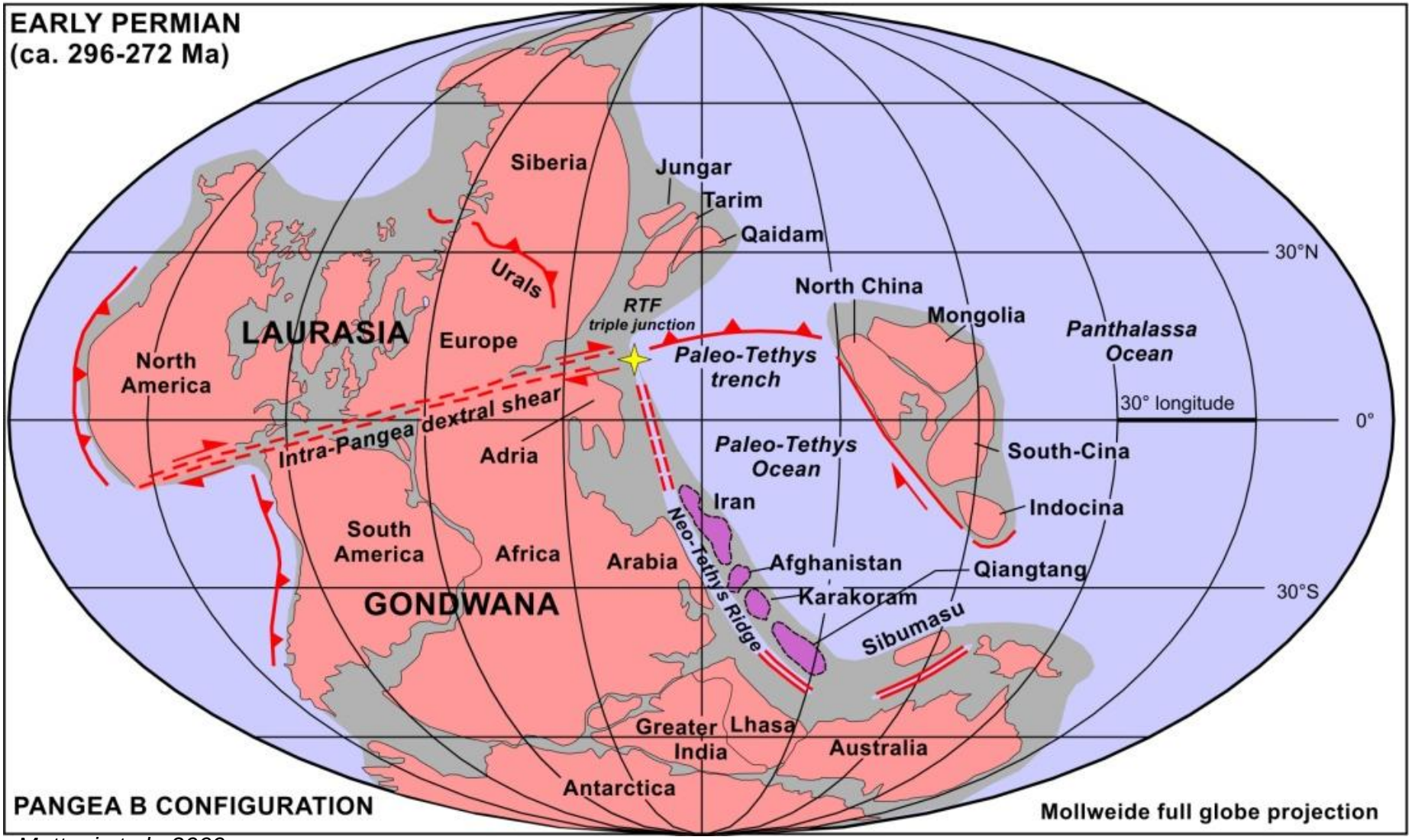


Aim of the presentation:

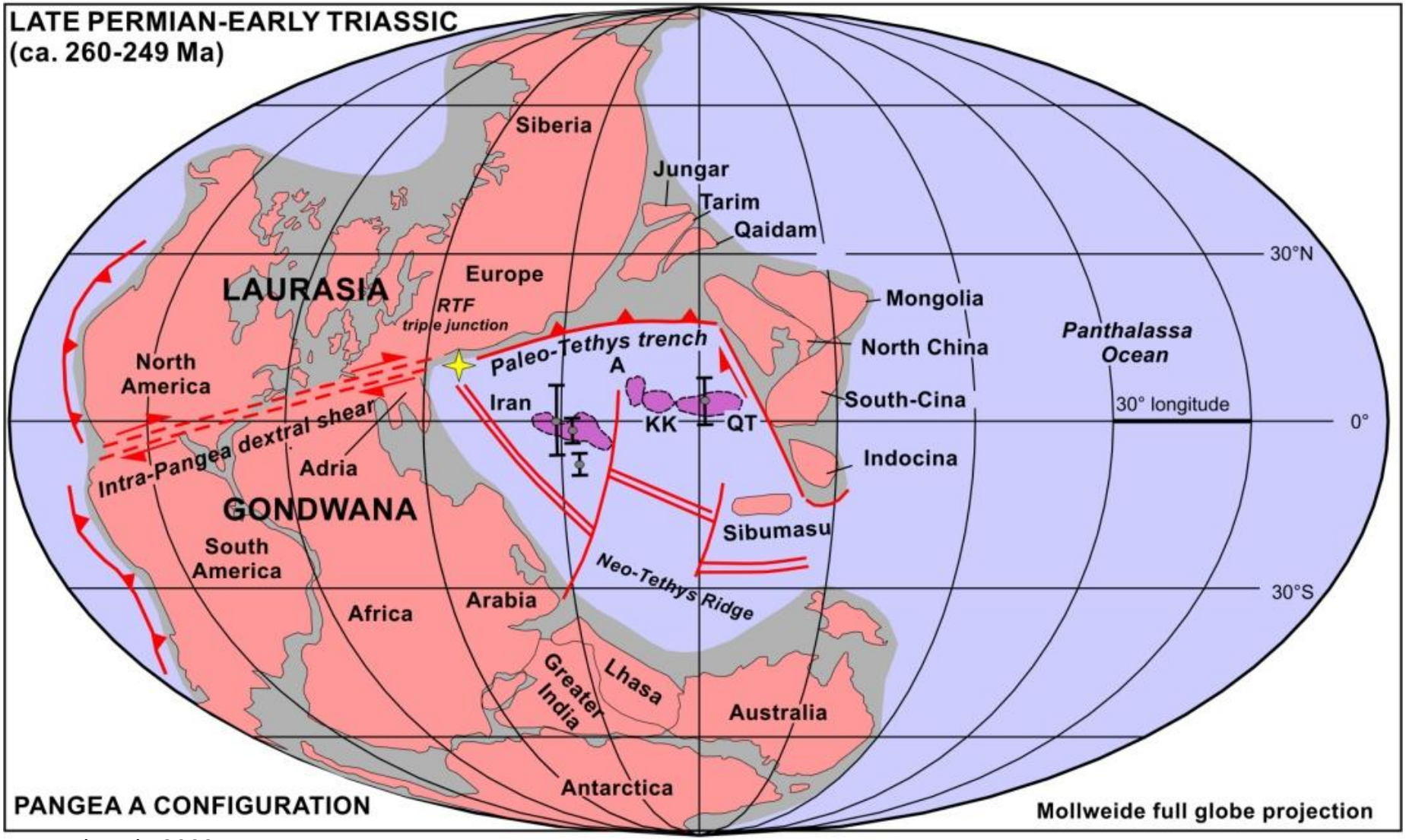
- **Analysis of the collision zone of NE-Iran**
- **Define the stratigraphic, structural and petrological features of the "Palaeotethys remnants"**
- **Reconstruct the Permo-Triassic evolution of the area**




Accretionary Wedge
MASHAD
Kashaf Rud
Kashaf Rud
Mashad granite
IRAN
61°
TURKMENISTAN
Aghdarband mine
Upper Permian clastics
36°
Malik
Aghdarband Triassic basin
Natu
Mamiza
Darreh Anjir Complex
Fariman Complex
Garm Ob
FARIMAN
Sefid Sang
Saleh Abad
M
Torbat Jam granite
35°30'
M
AFGHANISTAN
61°
Torbat Jam
Q.
P-Q.
Og.-Ng.
Eo. (sed./int)
Cretaceous
Jurassic -L.Cretaceous
Kashaf Rud Fm. (M.J)
Mashad Phyllite (?T-J)
Upper Triassic granite
Aghdarband Triassic, Miankuhi (M)
?Upper Permian clastics
Palaeotethys remnants
Sandstone and slates (Permian)
Limestone (Permian)
Basalts
Mashad accretionary wedge
Gabbros, ultrabasics
Greenschists
25 km
South Asian Margin
Dev.-Carb.

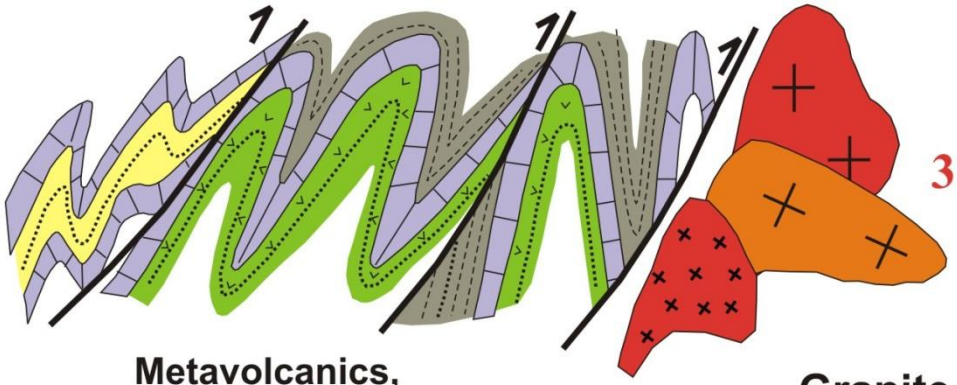


Muttoni et al., 2009



Muttoni et al., 2009

S-Asia Devonian-Carboniferous basement

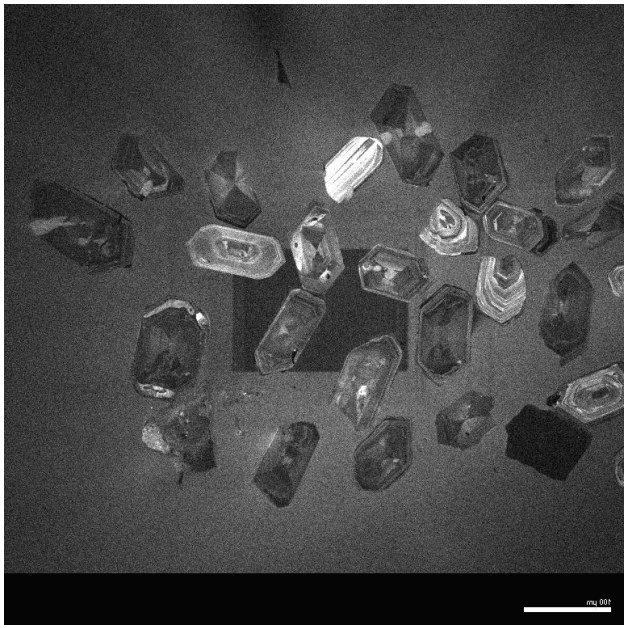


313.7 Ma U/Pb
(our data)

not exposed

Metavolcanics, marble, sandstone

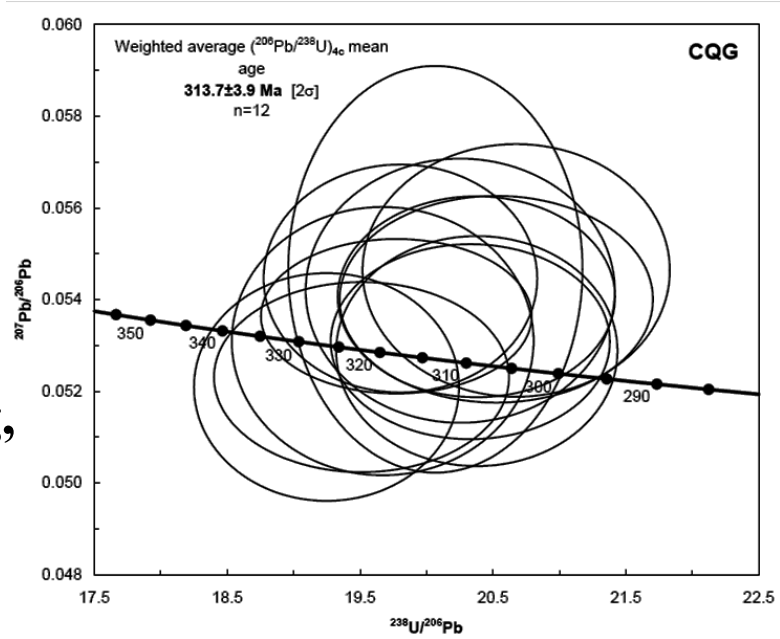
Granite



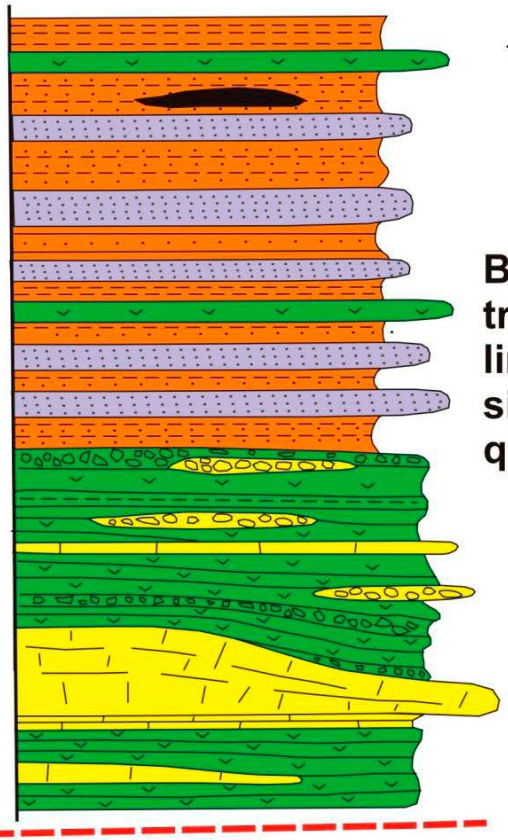
Granite cobble in Kara Gheitan:

313.7 Ma U/Pb

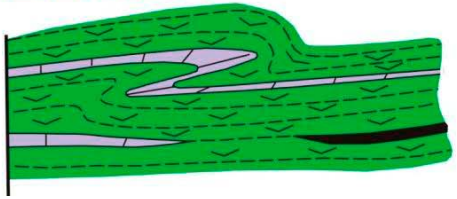
(University of Beijng, SROS Laboratory Milano-Bicocca)



Fariman Complex

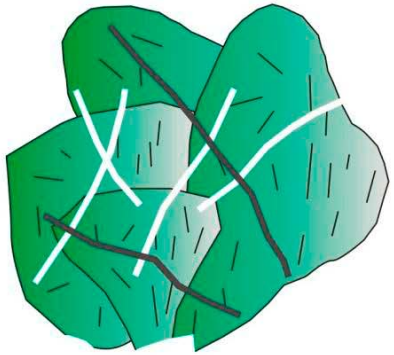


Basalt,
trachy-andesite,
limestone,
siliciclastic turbidite,
quartzarenite

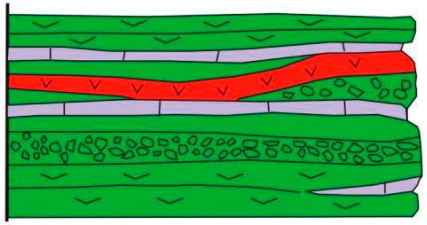


LG metabasalt,
marble, serpentinite

Darreh Anjir Complex

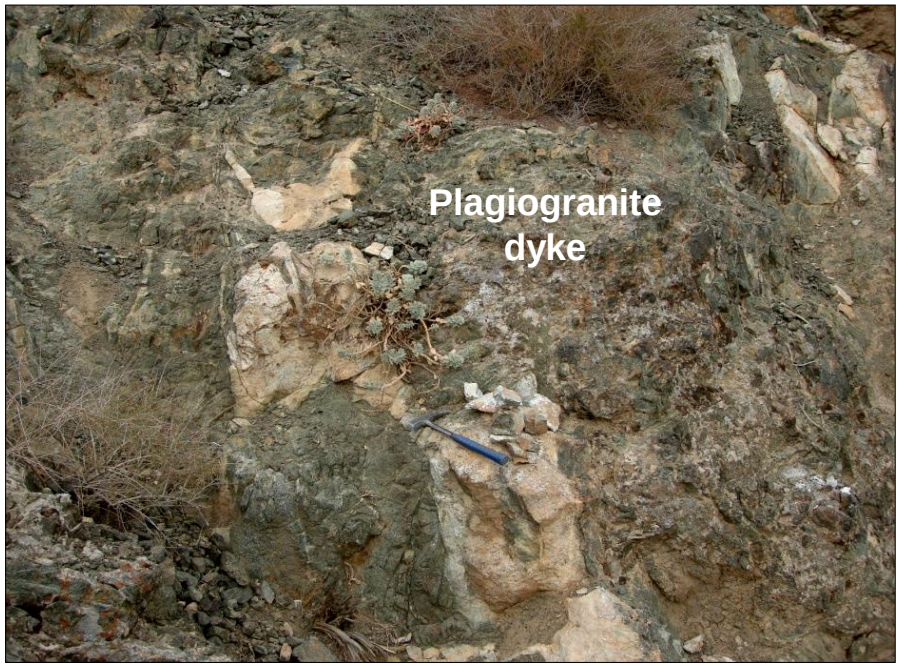


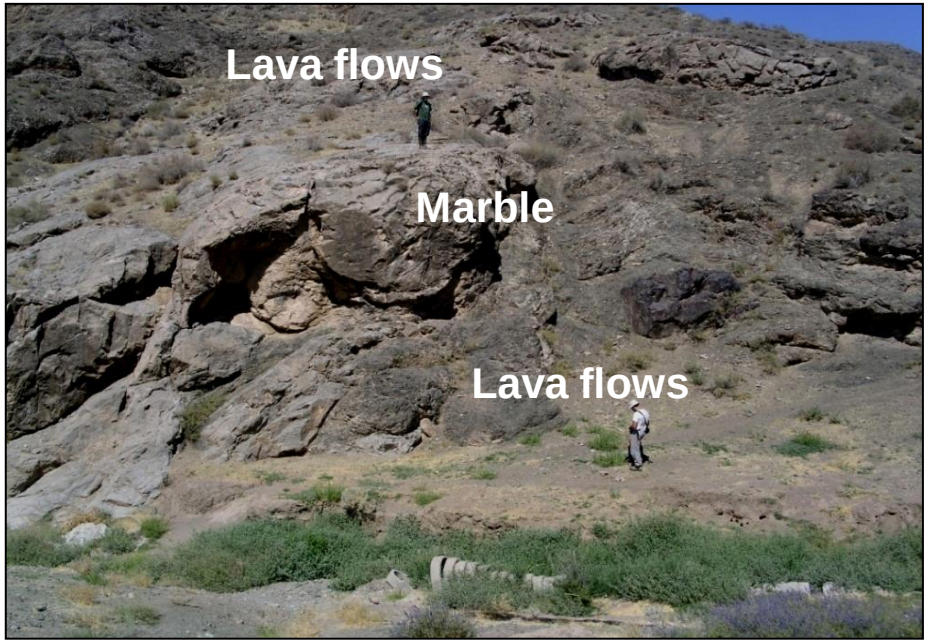
Layered gabbros,
plagiogranite dikes,
basaltic dikes



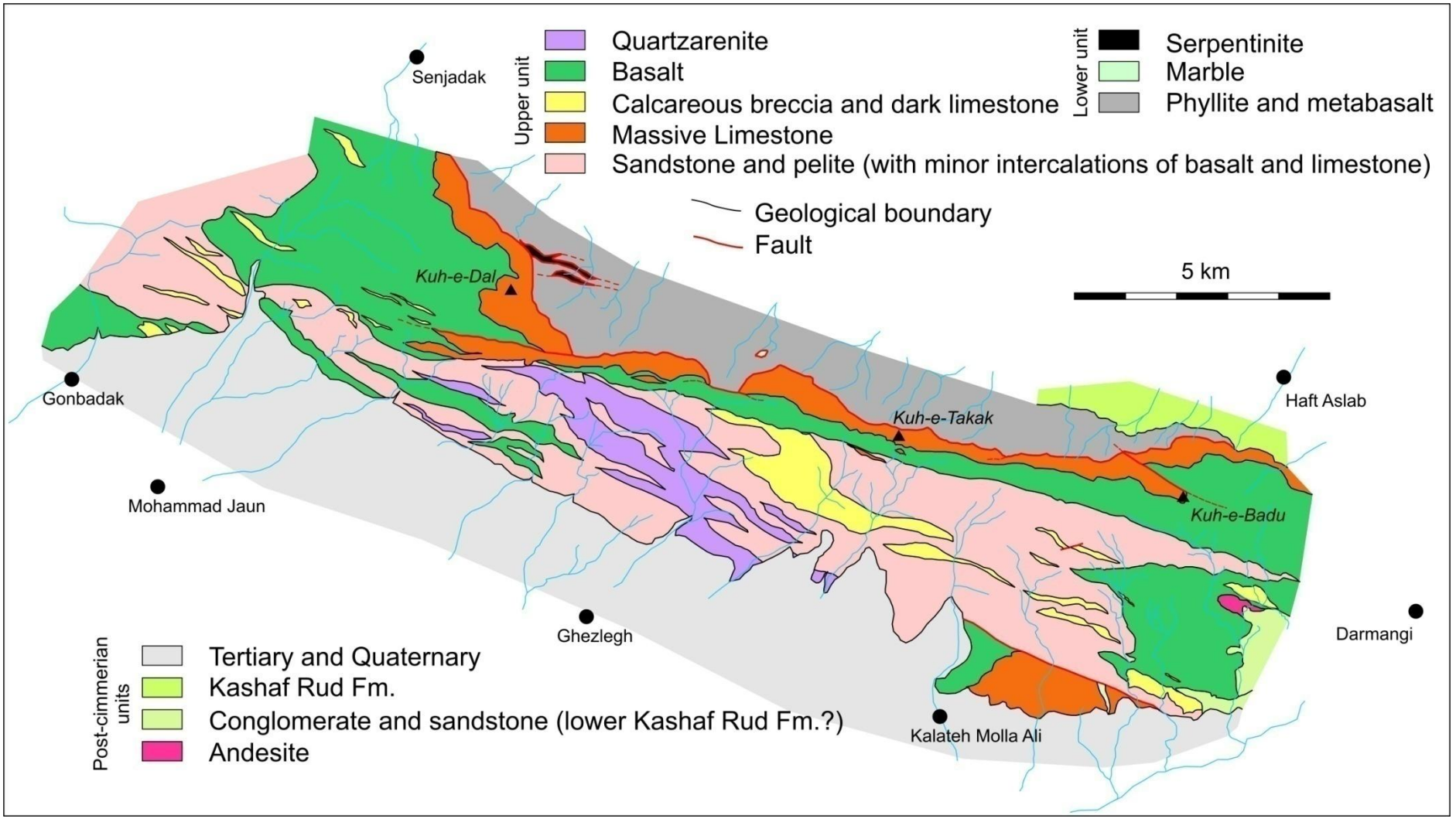
LG metabasalt, trachyte,
marble, metachert


Layered
gabbro


Plagiogranite
dyke

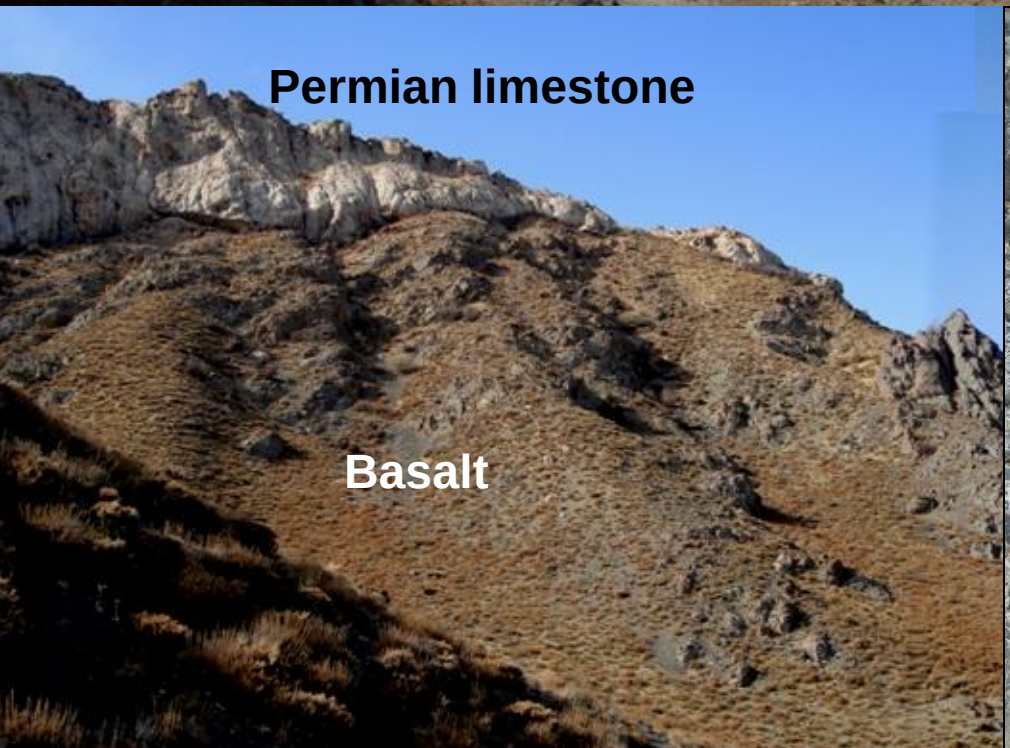

Lava flows
Marble
Lava flows


Radiolarite

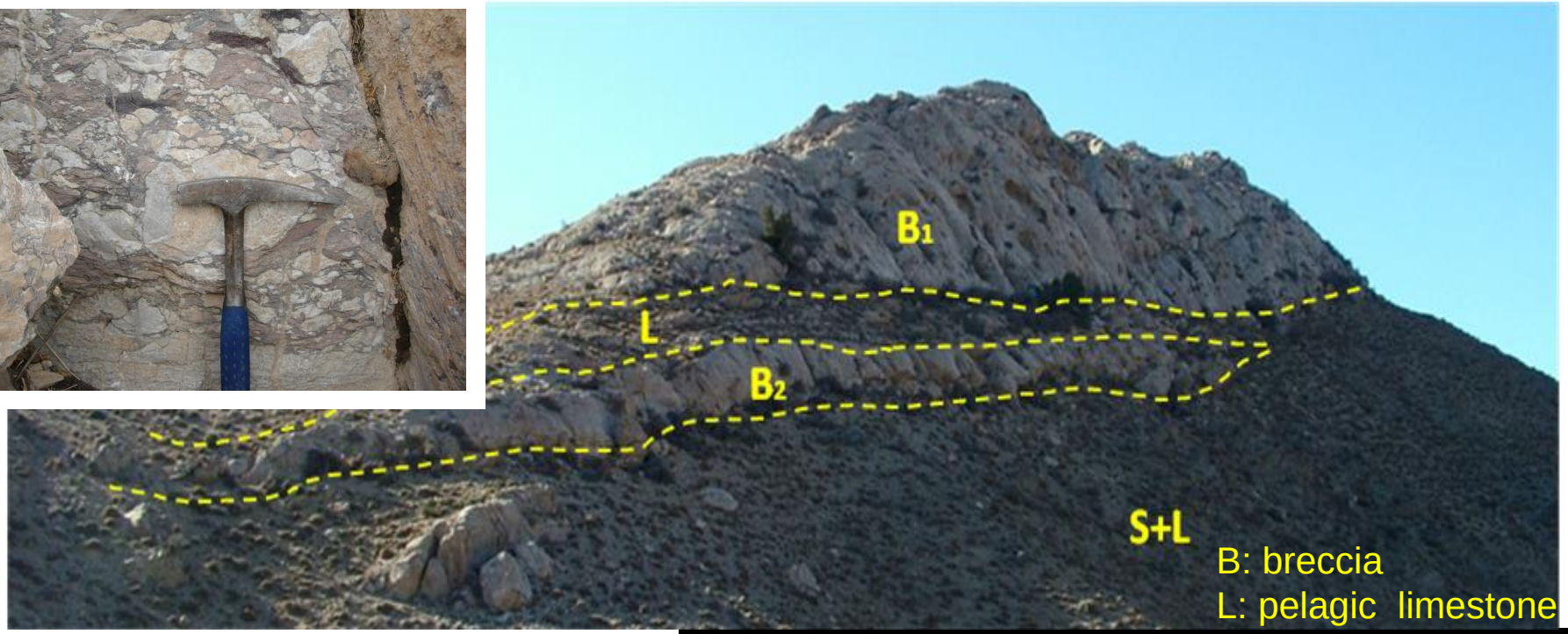


Schematic geological map of the Fariman Complex


south
Permian limestone
north
UPPER UNIT
Lava flows (basalts) with
calcareous olistoliths
Turbiditic succession
LOWER UNIT
Greenschist, phyllite,
with serpentinite


Permian limestone
Basalt


Pillow lava basalt

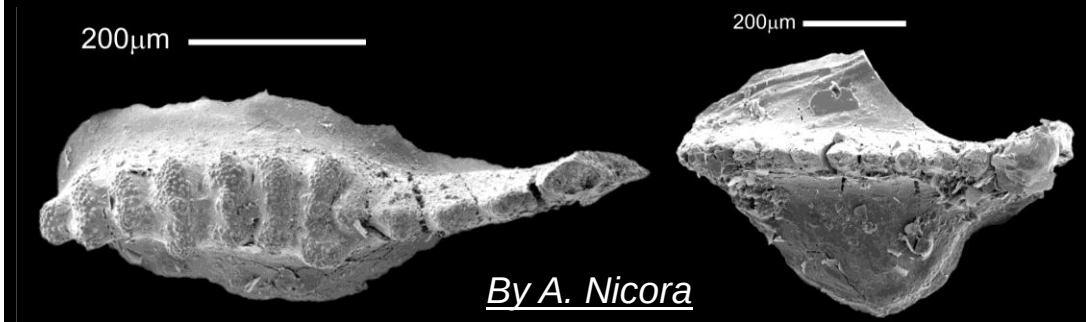


B: breccia
L: pelagic limestone

Kungurian (Early Permian)

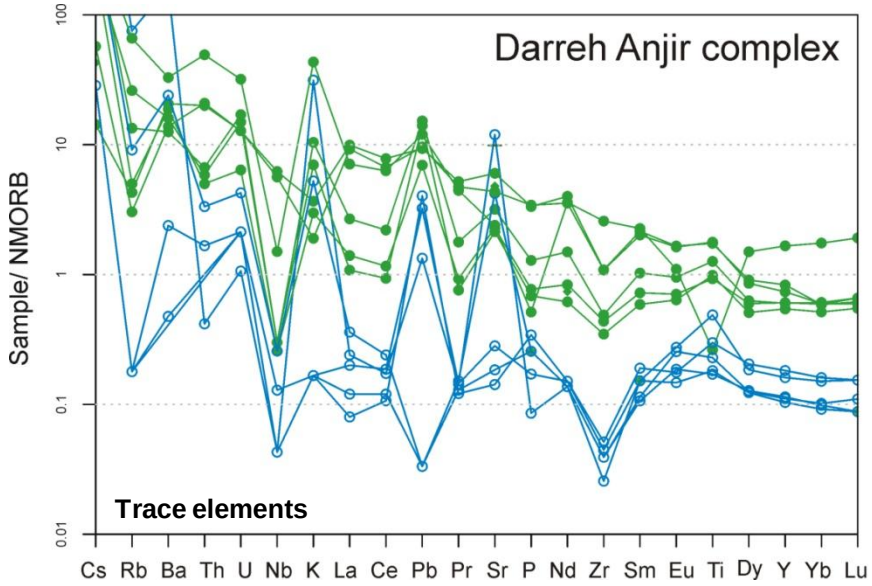
Sweetognathus guizhouensis

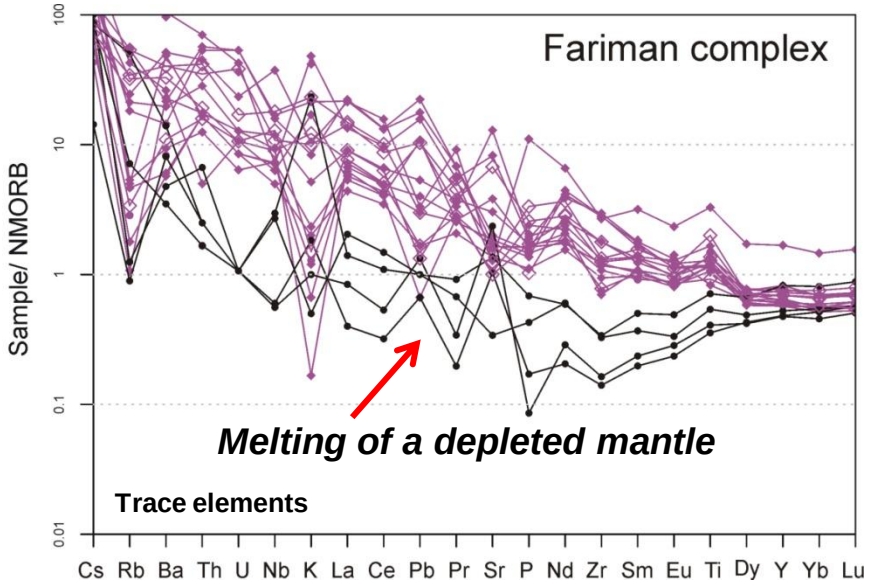
Pseudohindeodus* cf. *nassichuki

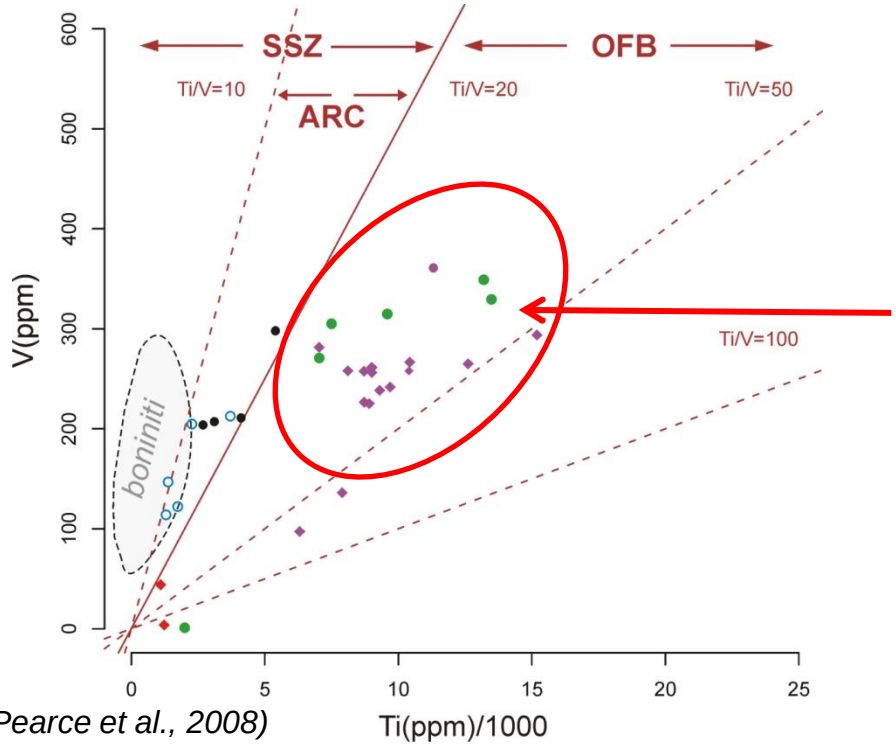


By A. Nicora

GEOCHEMISTRY OF THE FARIMAN AND DARREH ANJIR "OPHIOLITES"







(Pearce et al., 2008)

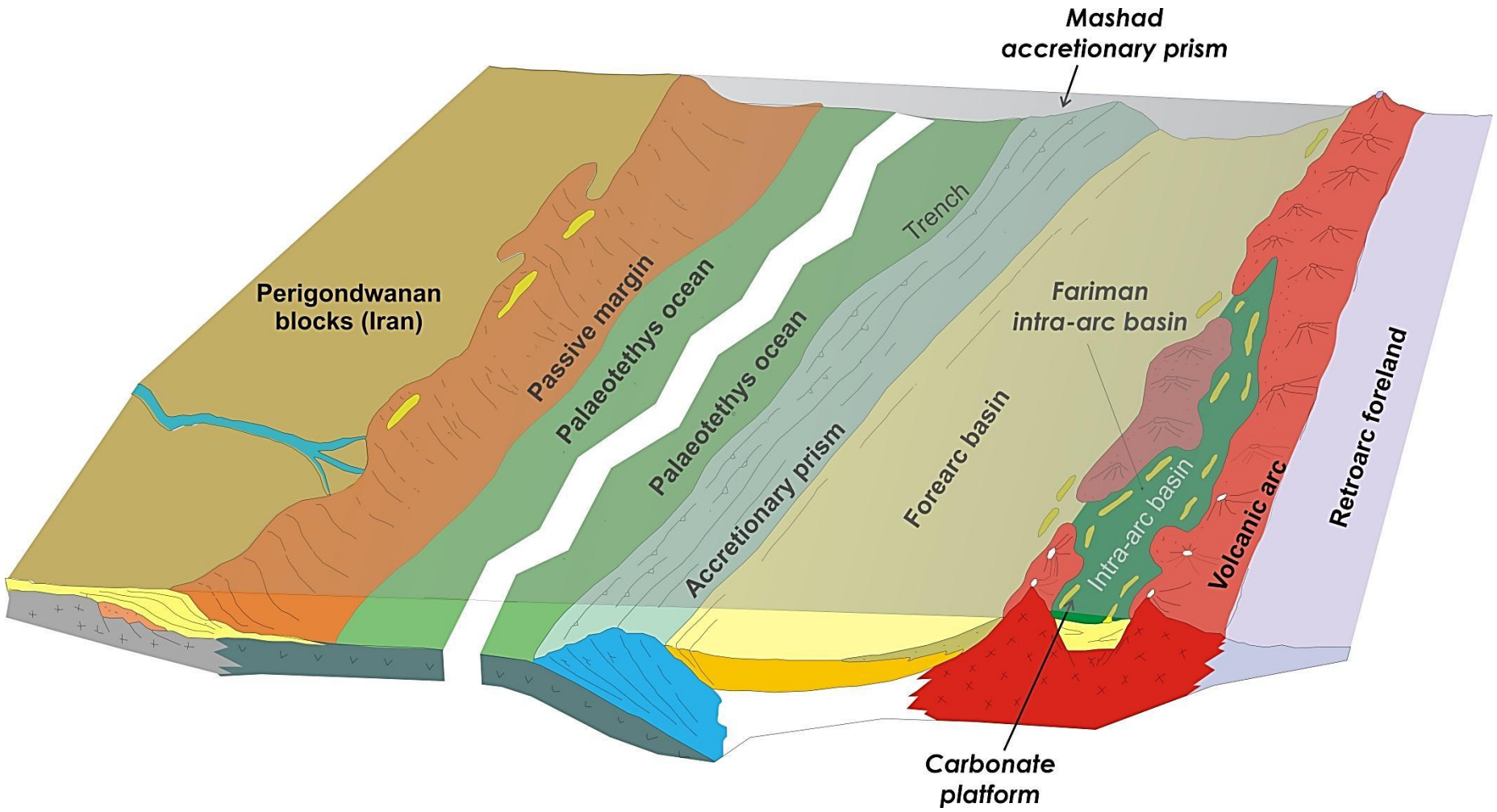
No MORB affinity: no ophiolites s.s.

Darreh Anjir gabbros: subduction-related magmatism (low Ti, Nb, Zr)

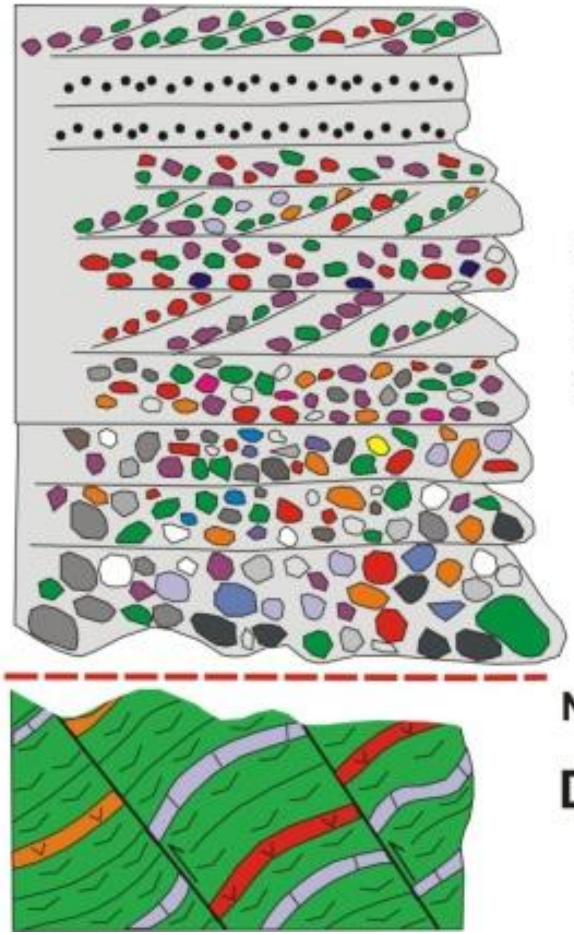
Darreh Anjir and Fariman basalts: metasomatised mantle source tapped in a back-arc or intra-arc basins

- Darreh Anjir: gabbros
- Darreh Anjir: lavas
- Darreh Anjir: plagiogranite
- Fariman: basalts lava flows
- Fariman: SE basalts

Reconstruction of the SE Eurasian margin during the Middle Permian



Upper Permian clastics

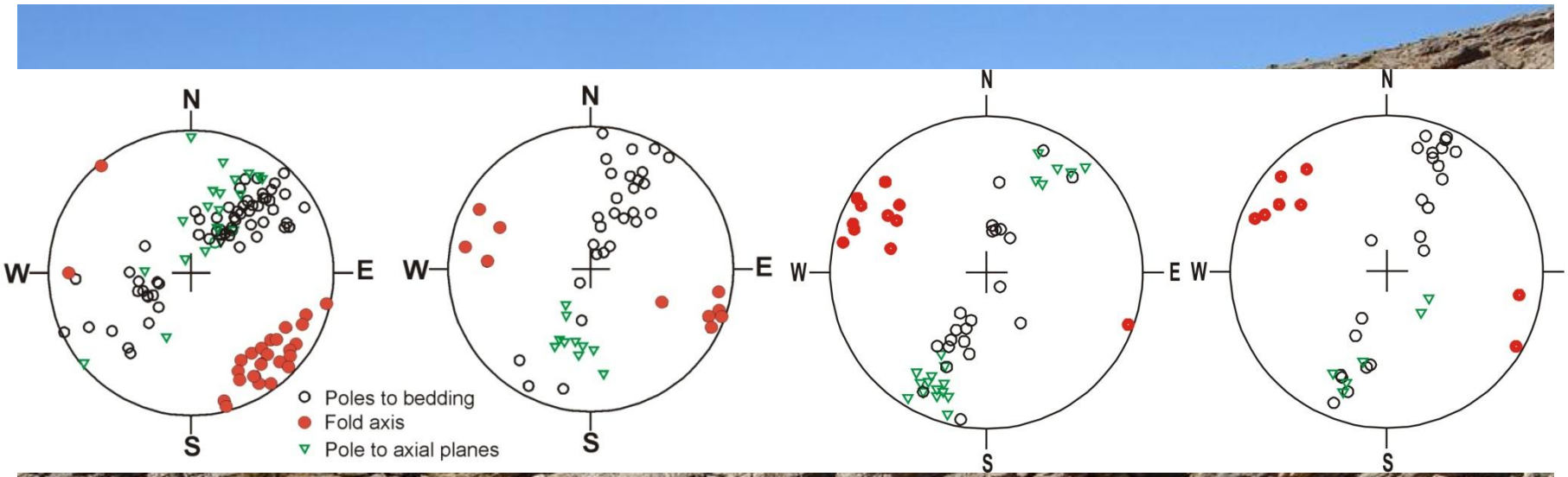


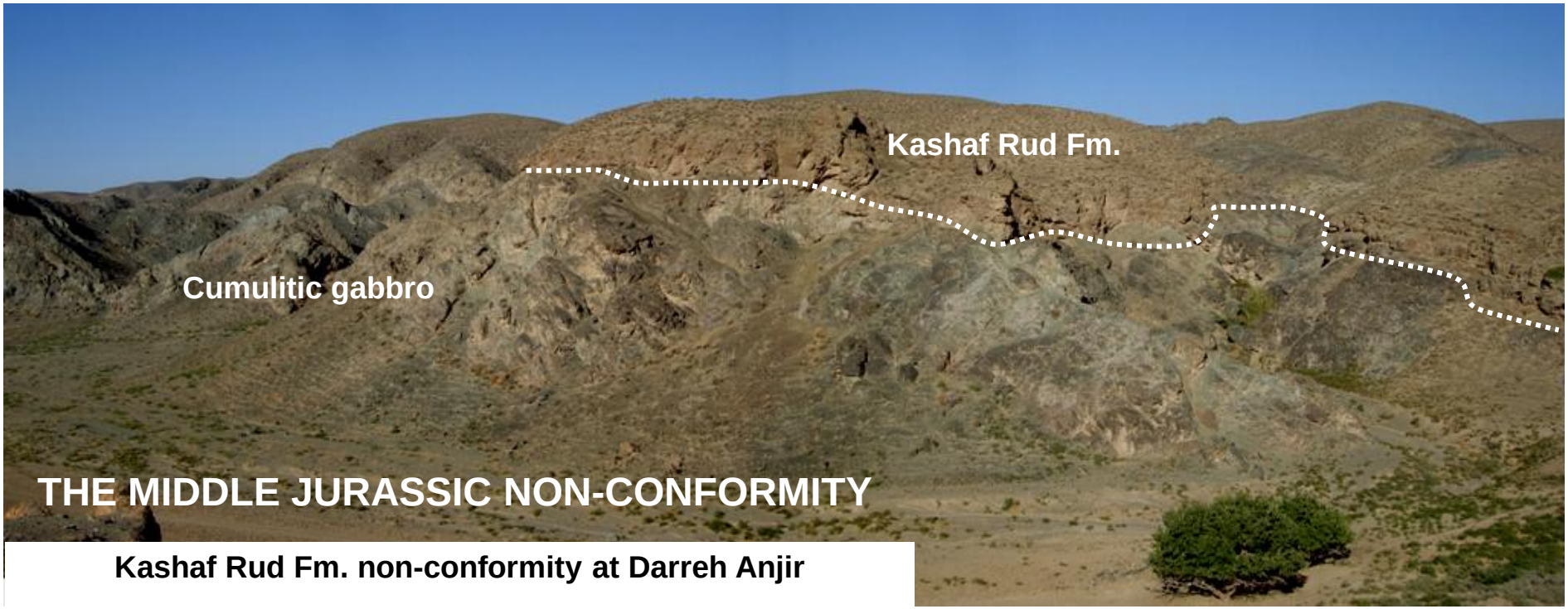
Polymict conglomerate and sandstone

Non-conformity ?

Darreh Anjir Complex

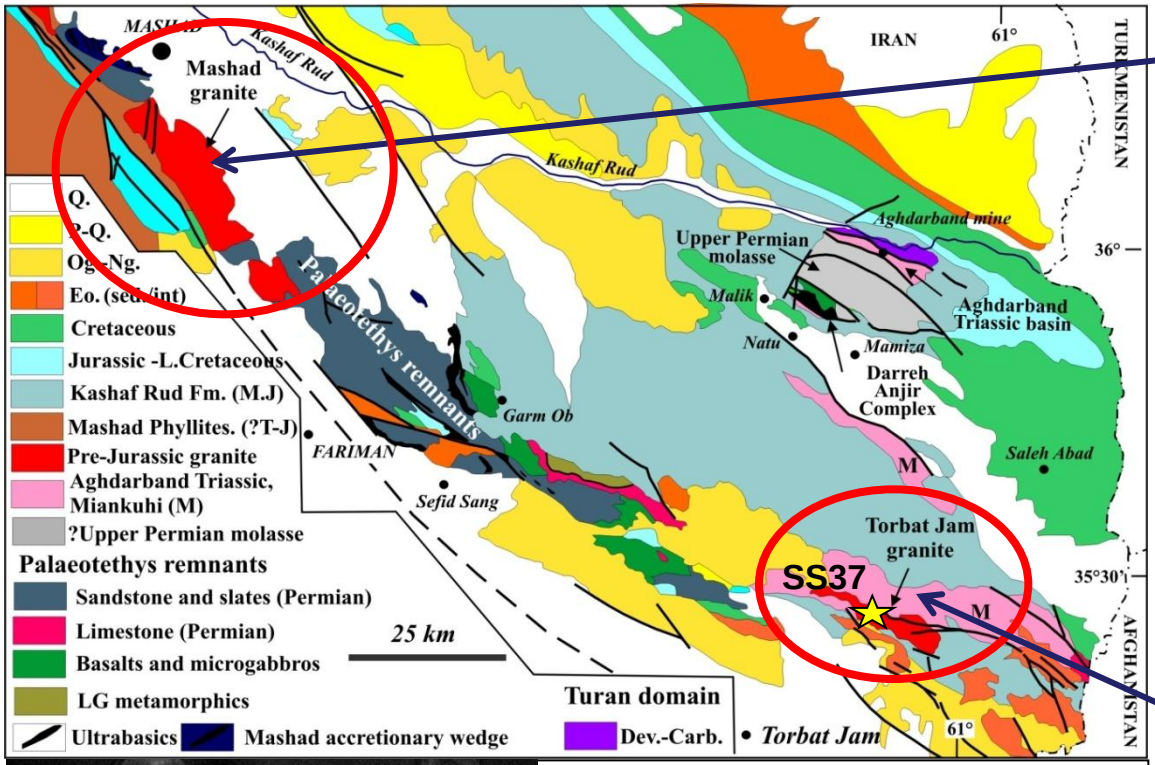
THE FARIMAN COMPLEX: STRUCTURE

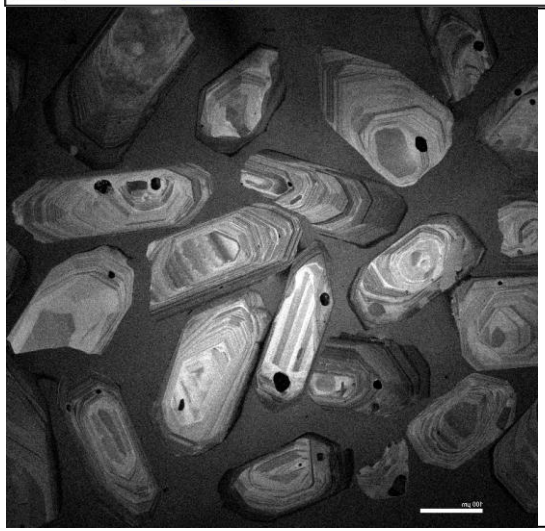


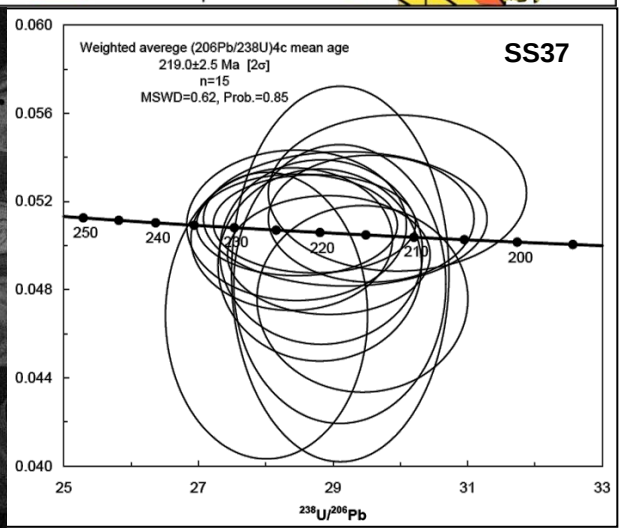


Kashaf Rud Fm. non-conformity at Darreh Anjir

- Tectonic contact between the gabboric complex and the basalts-cherts-marble unit
- Basalts are possibly unrelated to the underlying gabbros
- No Penrose-type ophiolites, no layer-cake structure
- Age constraints: U-Pb on zircons (plagiogranite, radiolarian from cherts (under study)





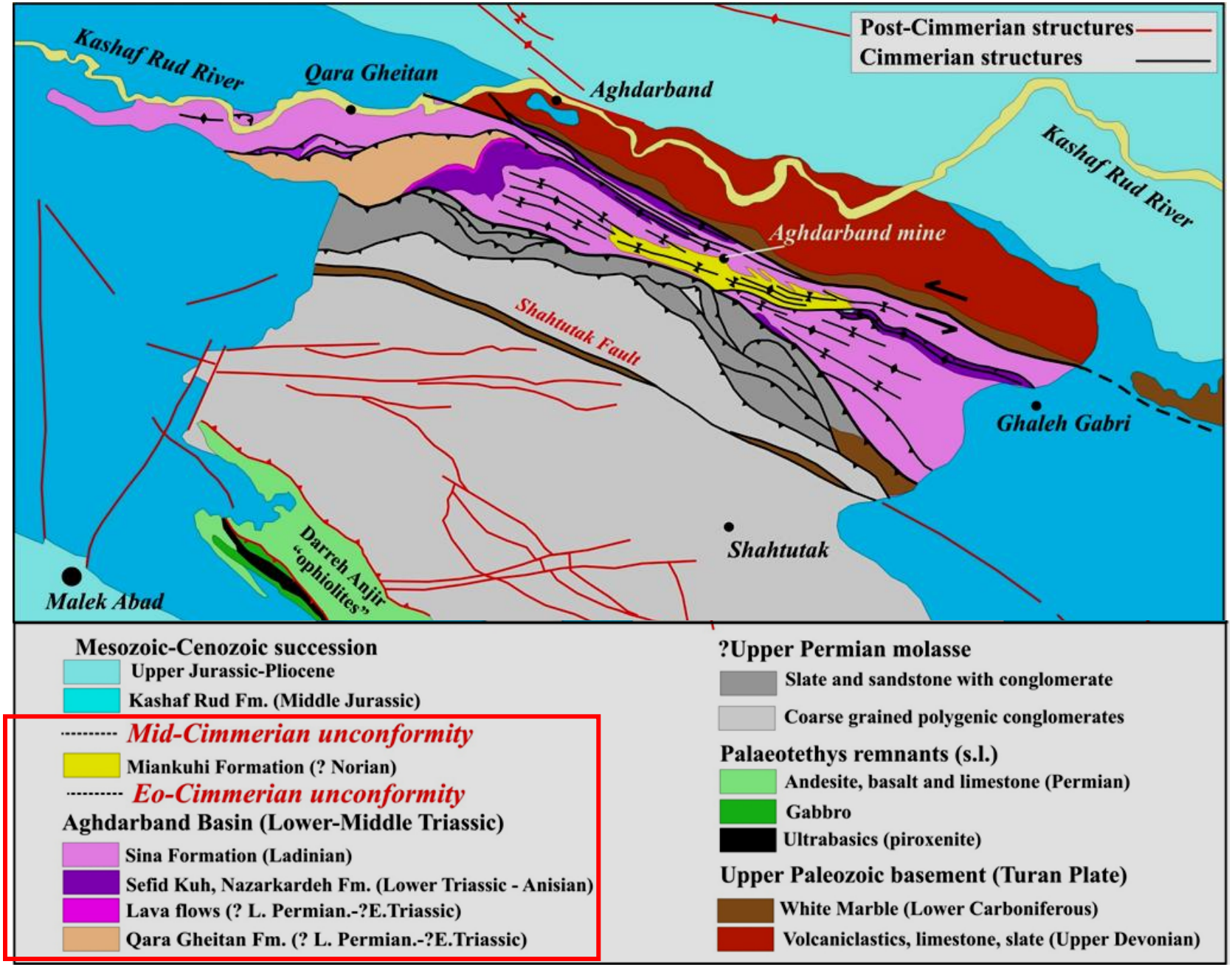


Mashad intrusives:
215-217 Ma *(Karimporur et al., 2010)*

Pre-early Norian deformation of the Fariman Complex

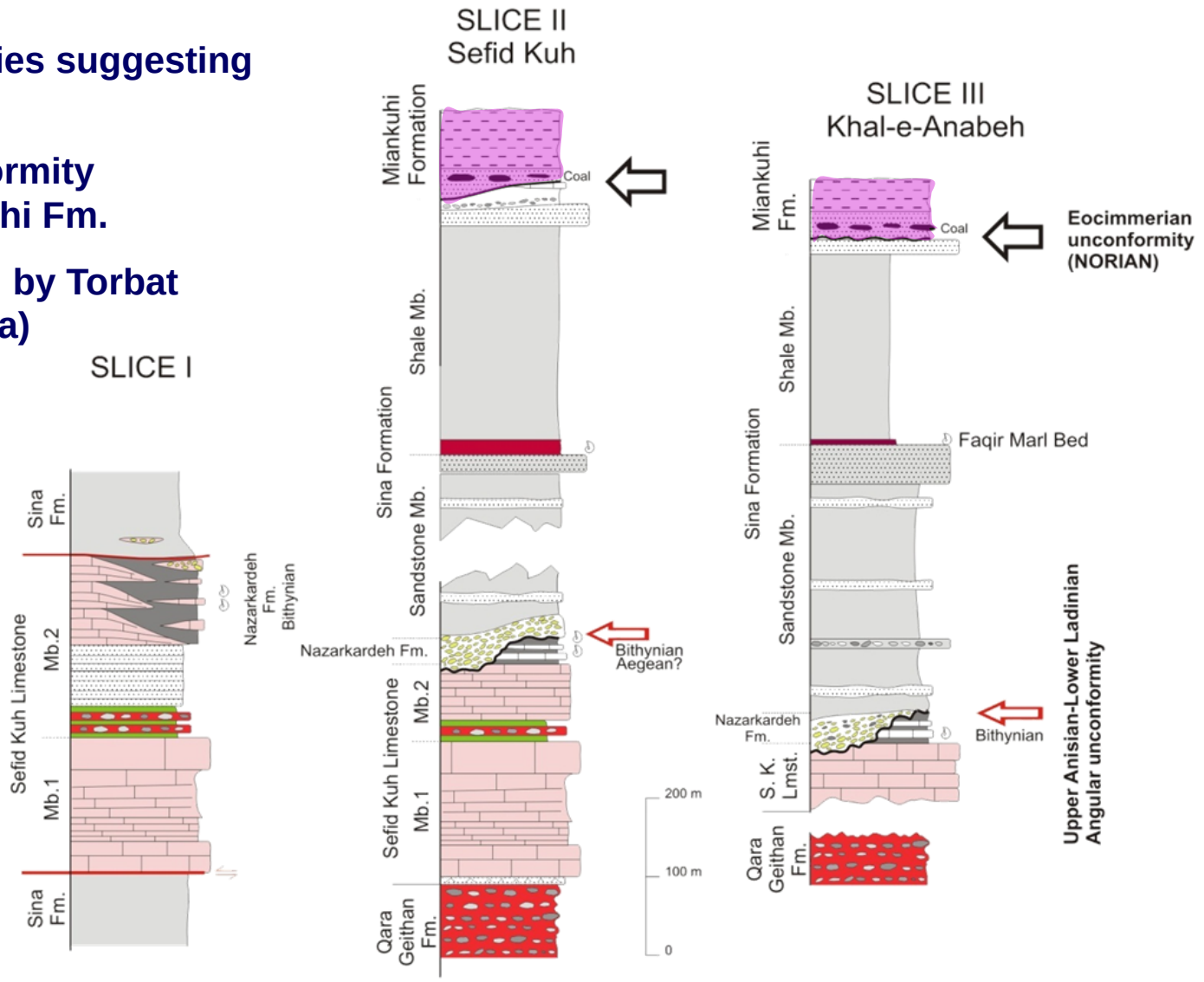
Torbat Jam granite:
218-221 Ma *(own data)*

The Aghdarband erosional window

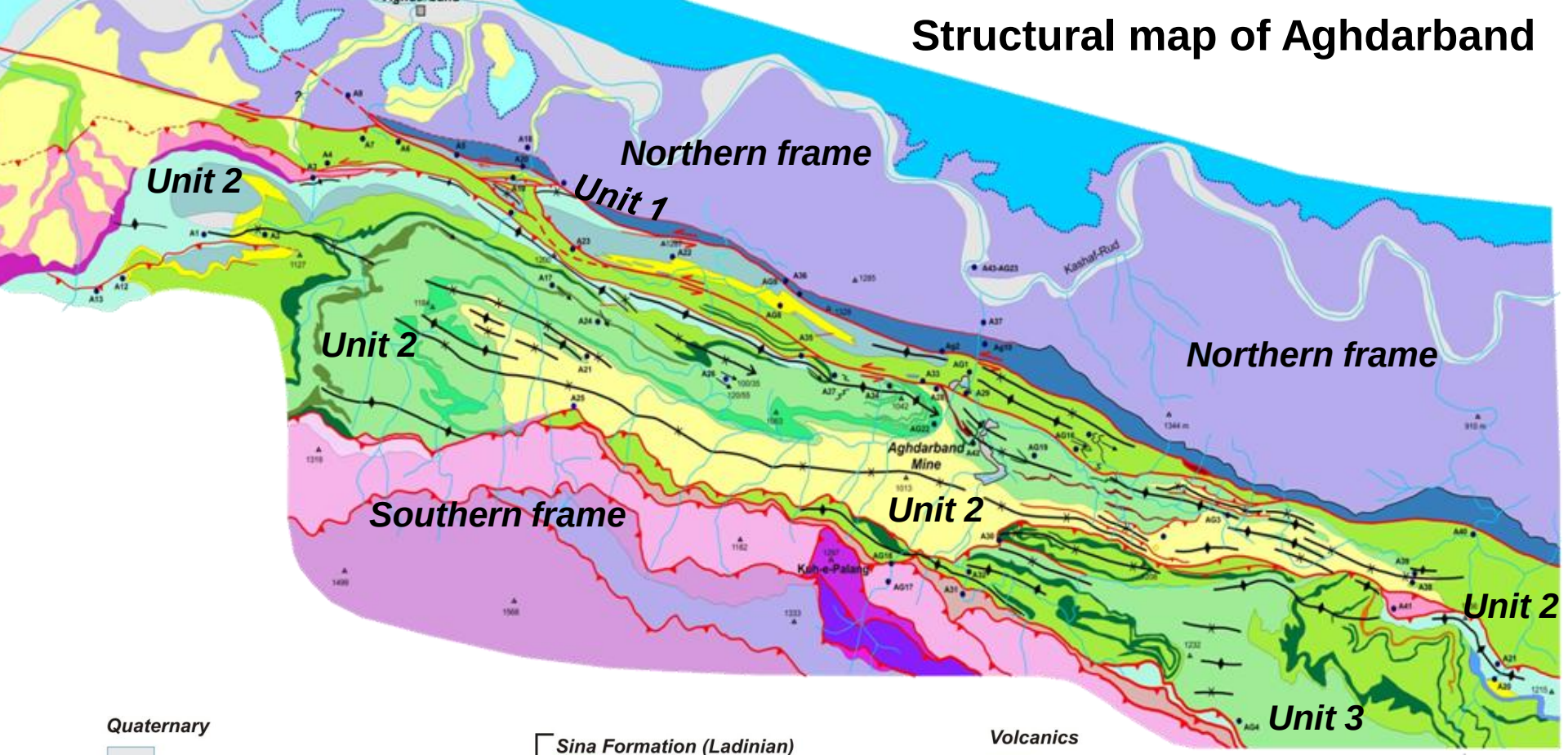


Stratigraphy of the Triassic Aghdarband Basin

- **Different successions in each thrust sheet**
- **Important unconformities suggesting fault activity**
- **Eo-Cimmerian unconformity recorded by the Miankuhi Fm.**
- **Miankuhi Fm. intruded by Torbat Jam Granite (218-221 Ma)**



Structural map of Aghdarband



Quaternary
- Kashaf Rud alluvial deposits
- Loess cover and alluvial deposits

Post-Cimmerian sequence
- Upper Jurassic-Cretaceous
- Kashaf Rud Fm. (Bajocian)

Upper Palaeozoic (Northern Frame)
- Marble (Early Carboniferous)
- Limestone and shale (Late Devonian) with undifferentiated slate and sandstone

Miankuhi Formation (Norian)
- Shale with basal coal seams (Norian)

AGHDARBAND BASIN (TRIASSIC)

Sina Formation (Ladinian)
- Shale
- Tuff, lava and tuffaceous sandstone
- Conglomerate
- Volcaniclastic sandstone layers
- Anabeh conglomerate
- Sandstone
- Conglomerate with limestone pebbles

Nazarkardeh Formation (Anisian)
- Nodular limestone

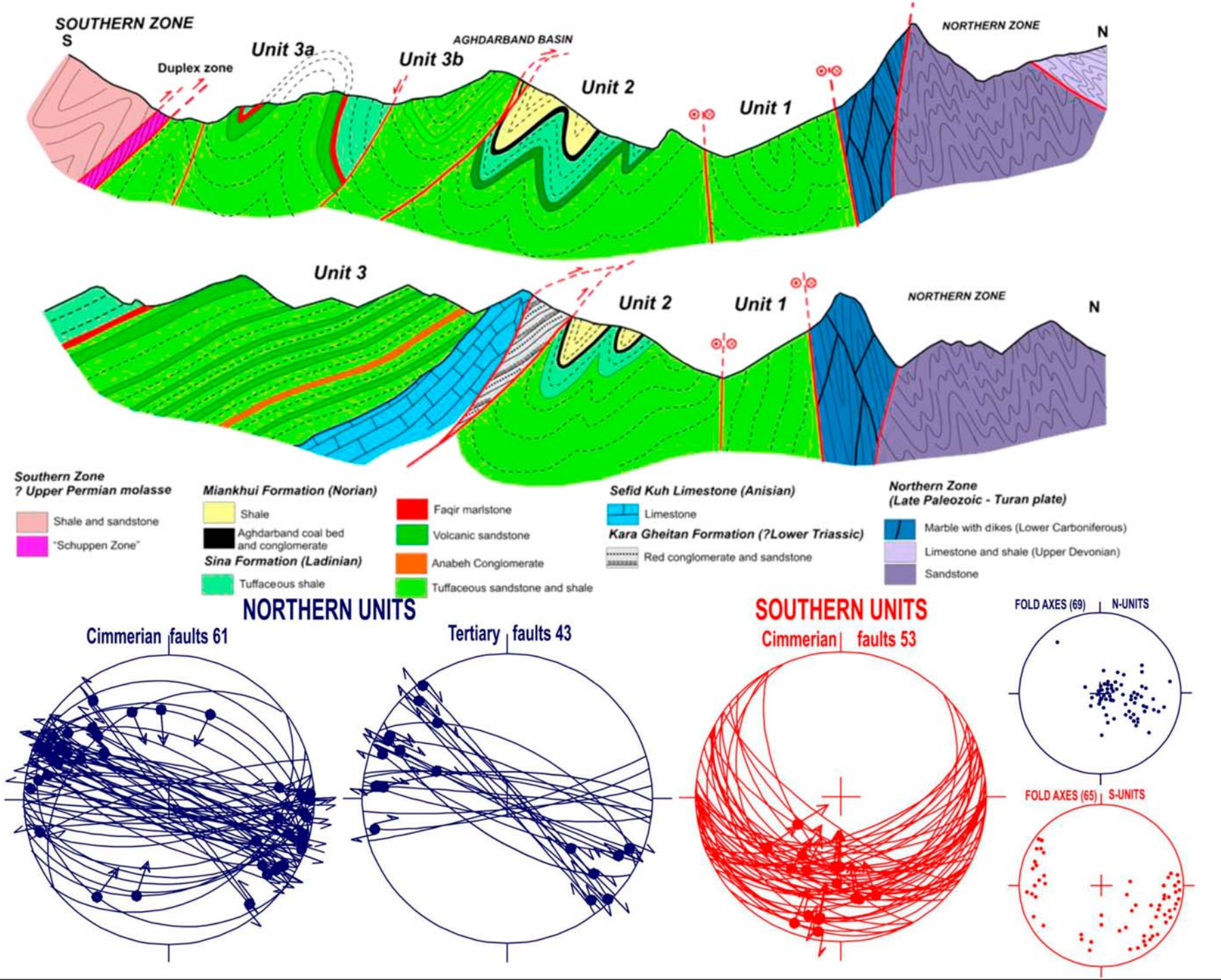
Sefid Kuh Limestone (Early Triassic)
- Upper member: well bedded limestone
- Lower member: massive limestone

Volcanics
- Massive lava flows

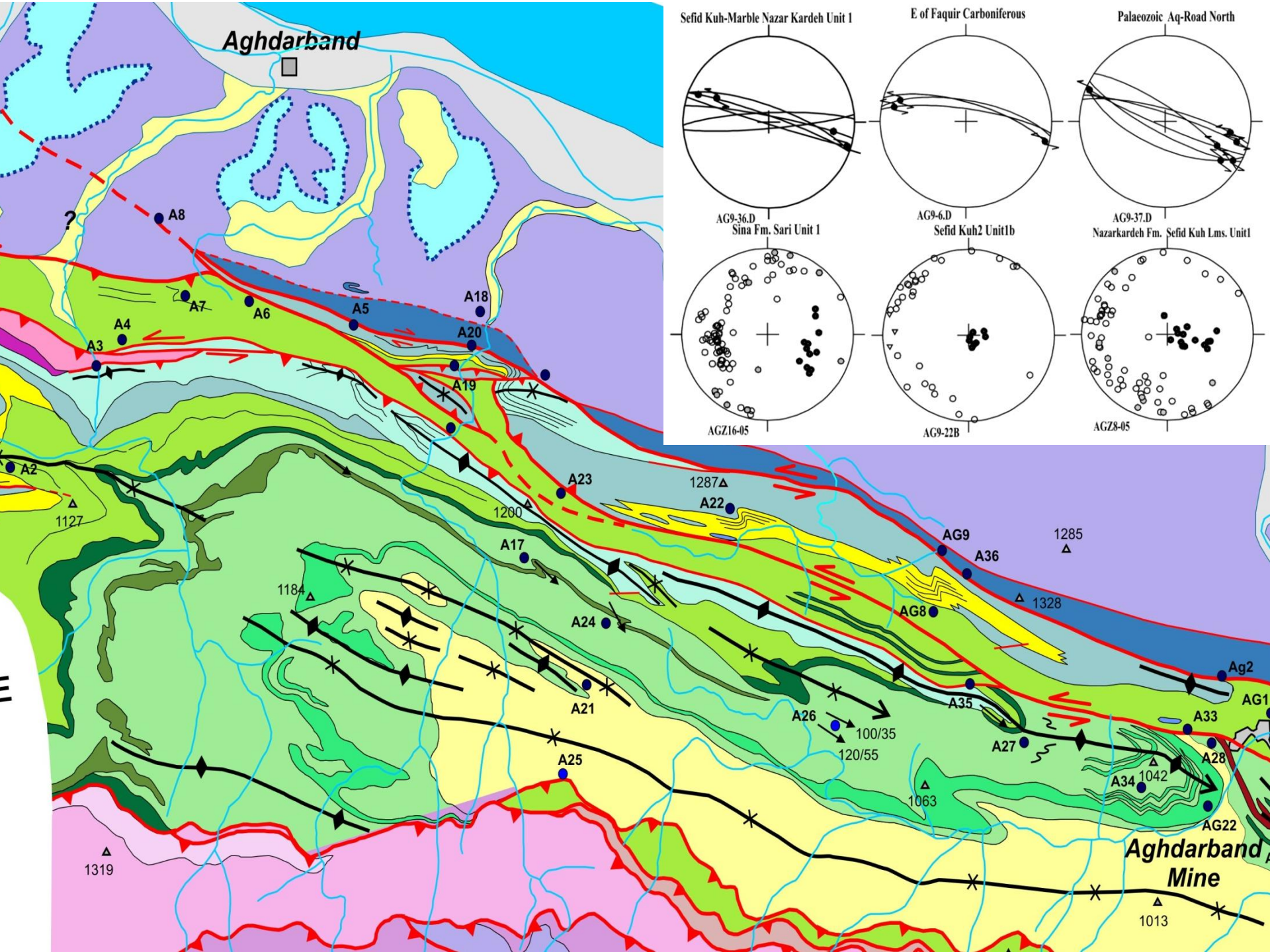
Qara Geithan Formation
- Conglomerate and sandstone

Late Permian ?- Early Triassic ? (Southern Frame)
- Imbricate thrust slices
- Shale and sandstone
- Sandstone and conglomerate
- Sericitic slates
- Sandstone
- Sericitic slates

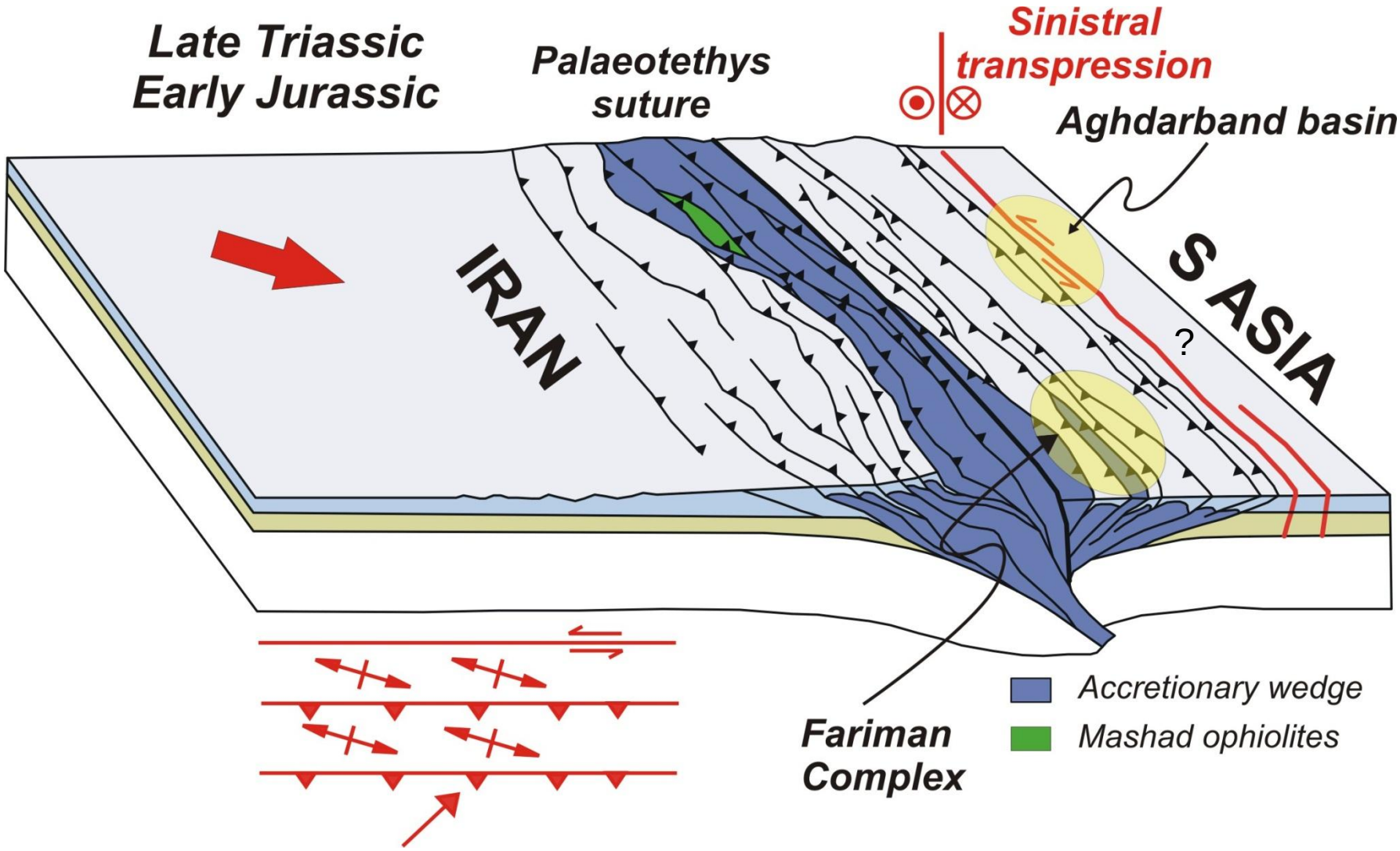
Modified from Ruttner, 1991


SOUTHERN ZONE
S
Duplex zone
Unit 3a
Unit 3b
AGHDARBAND BASIN
Unit 2
Unit 1
NORTHERN ZONE
N
Unit 3
Unit 2
Unit 1
NORTHERN ZONE
N
Southern Zone
? Upper Permian molasse
Shale and sandstone
"Schuppen Zone"
Miankhui Formation (Norian)
Shale
Aghdarband coal bed and conglomerate
Sina Formation (Ladinian)
Tuffaceous shale
Faqir marlstone
Volcanic sandstone
Anabeh Conglomerate
Tuffaceous sandstone and shale
Sefid Kuh Limestone (Anisian)
Limestone
Kara Gheitan Formation (?Lower Triassic)
Red conglomerate and sandstone
Northern Zone
(Late Paleozoic - Turan plate)
Marble with dikes (Lower Carboniferous)
Limestone and shale (Upper Devonian)
Sandstone
NORTHERN UNITS
Cimmerian faults 61
Tertiary faults 43
SOUTHERN UNITS
Cimmerian faults 53
FOLD AXES (69)
N-UNITS
FOLD AXES (65)
S-UNITS

VIEW TO THE SE OF THE NORTHERN FAULT ZONE


Aghdarband
Sefid Kuh-Marble Nazar Kardeh Unit 1
E of Faqir Carboniferous
Palaeozoic Aq-Road North
AG9-36.D
AG9-6.D
AG9-37.D
Sina Fm. Sari Unit 1
Sefid Kuh2 Unit1b
Nazarkardeh Fm. Sefid Kuh Lms. Unit1
AGZ16-05
AG9-22B
AGZ8-05
A8
A7
A6
A5
A18
A4
A3
A20
A19
A2
1127
A23
1287
A22
1200
A17
AG9
A36
1285
1184
A24
AG8
1328
Ag2
AG1
A35
A33
A21
A26
100/35
120/55
A27
A28
A25
A34
1042
1063
AG22
1319
Aghdarband
Mine
1013

E-PLUNGING FOLD NORTH OF AGHDARBAND


Late Triassic
Early Jurassic
Palaeotethys
suture
Sinistral
transpression
Aghdarband basin
IRAN
S ASIA
?
Fariman
Complex
Accretionary wedge
Mashad ophiolites

CONCLUSIONS