Analysis of the Structural Style and Fracture Distribution of the Ajdagh Anticline in Southern Kurdistan, Iraq
A model for fractured Carbonate Reservoirs

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GeoConsultants
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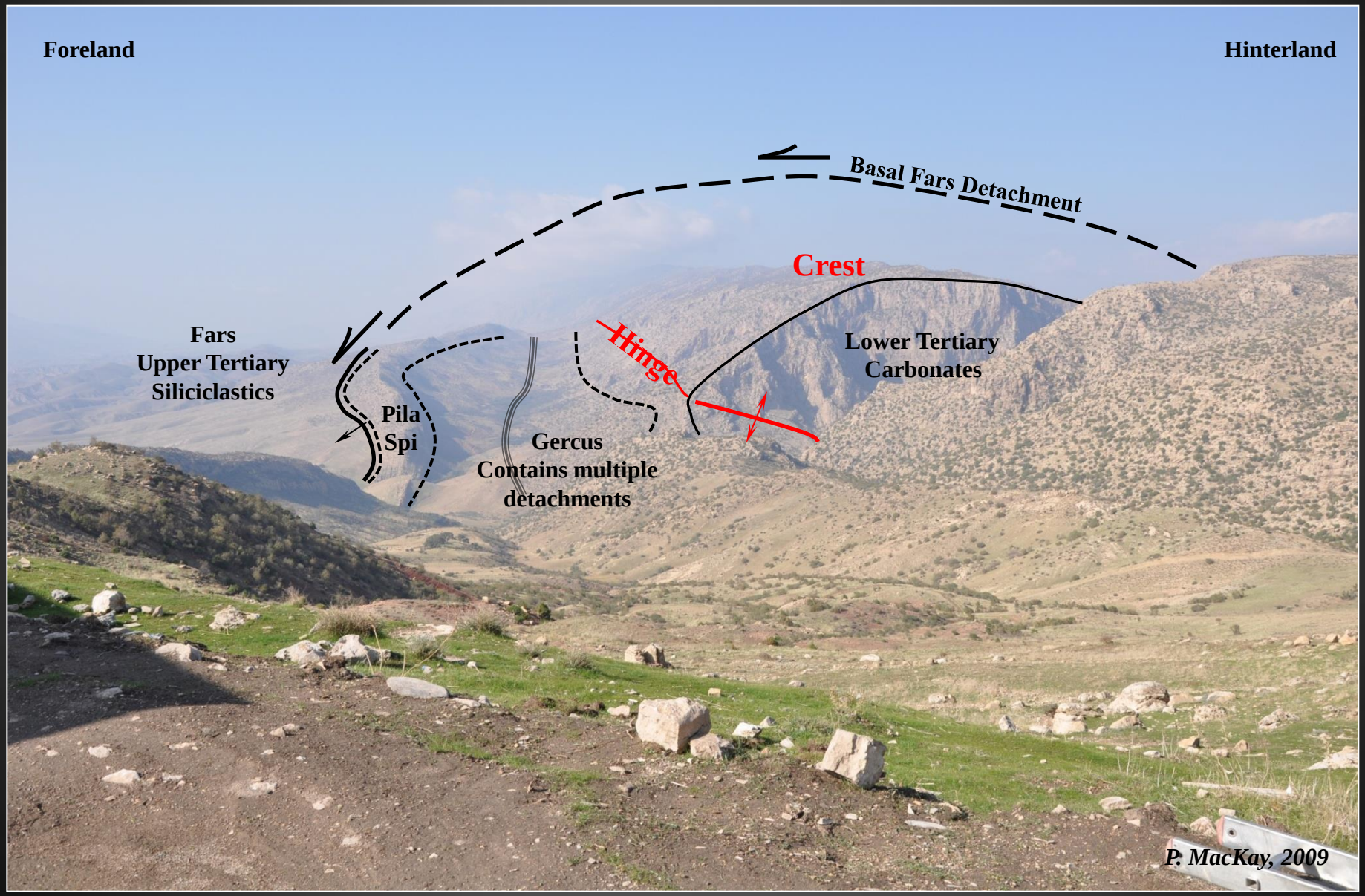
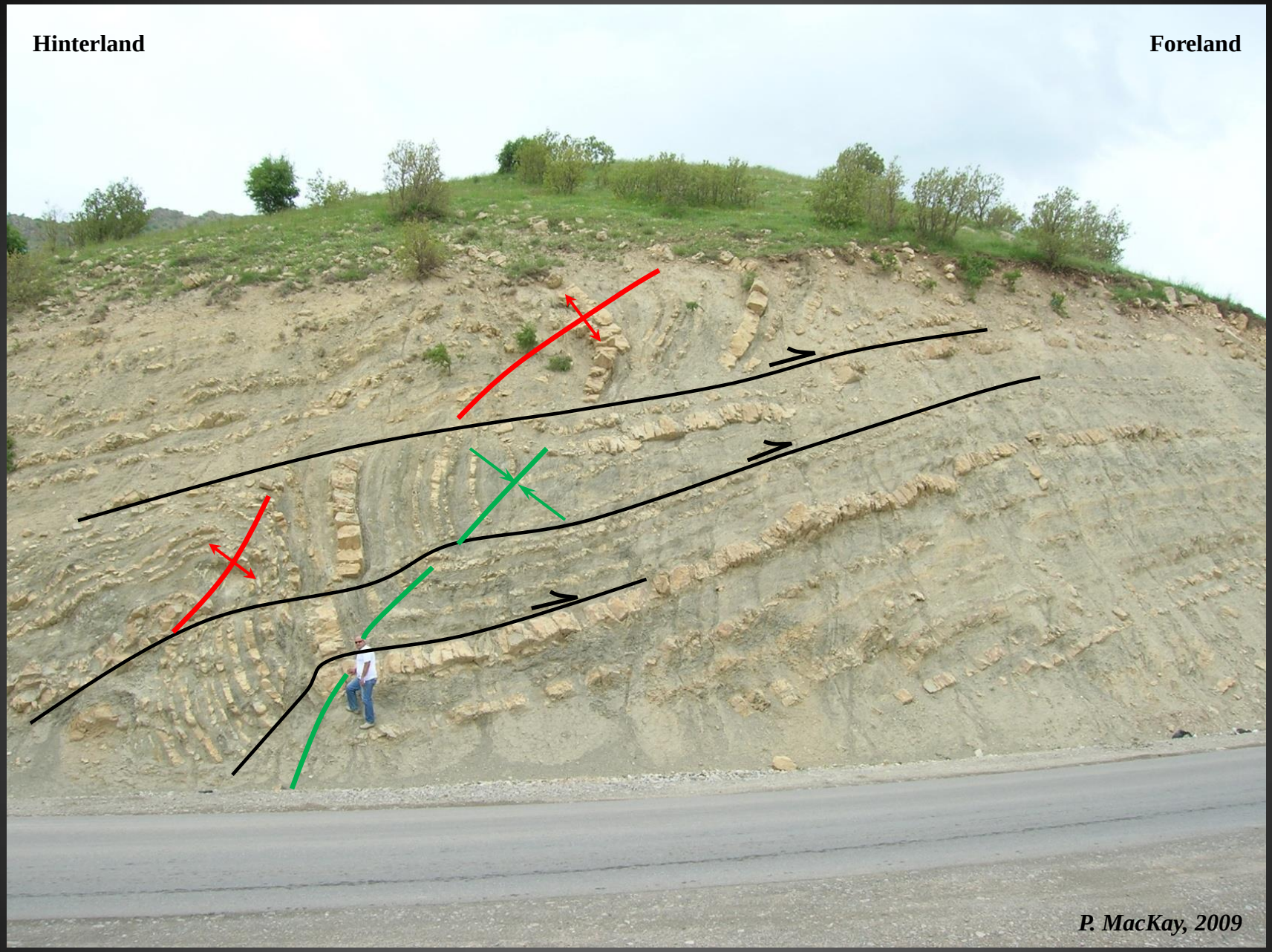
WesternZagros Resources Ltd.

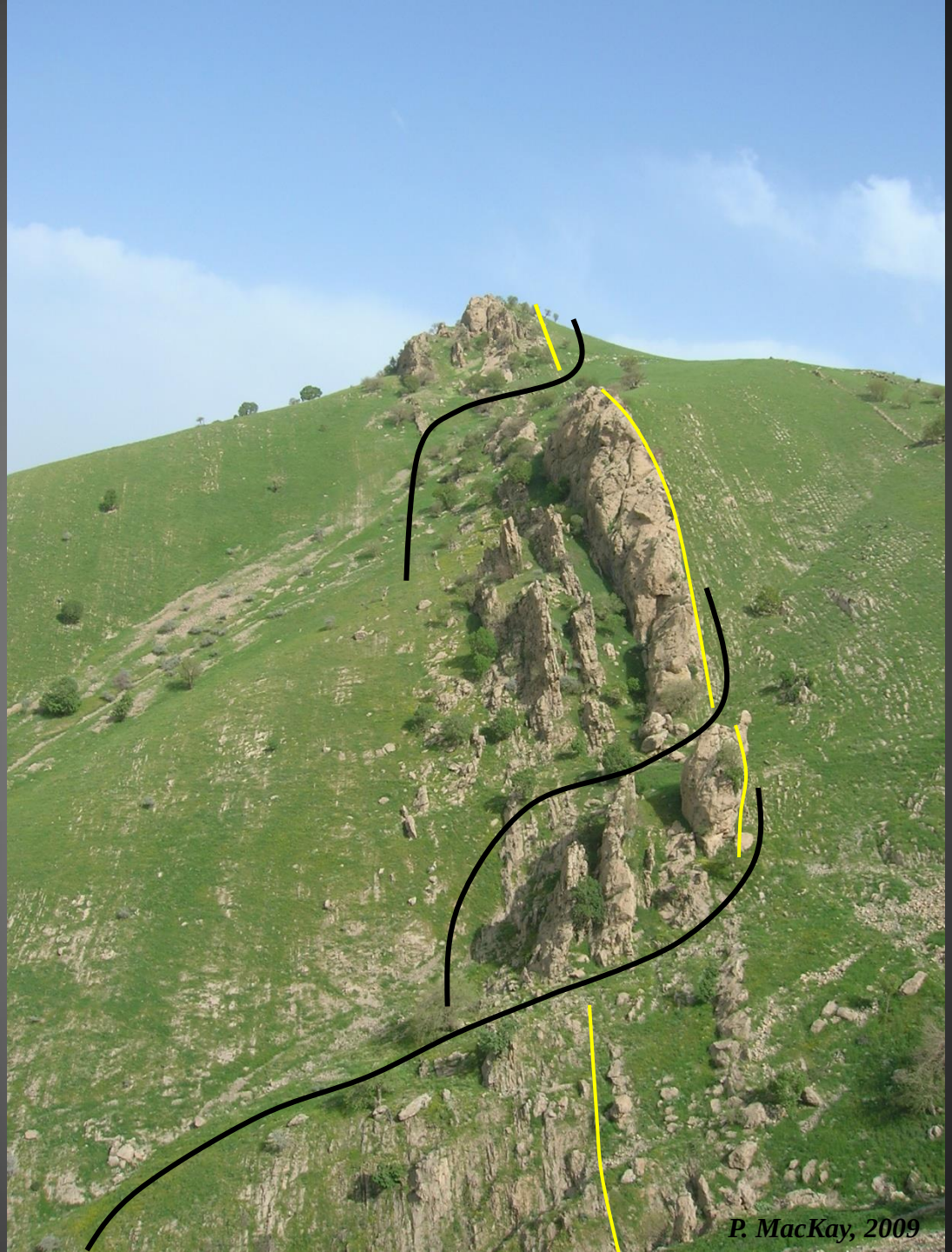
Turkey
Syria
Iraq
Jordan
Iran
Saudi Arabia
Kirkuk Embayment
Sirwan Trough
Ajdagh Anticline
Eurasian Plate
Arabian Plate
Zagros Mountains
Method:
focal mechanism
breakouts
drill. induced frac.
borehole slotter
overcoring
hydro. fractures
geol. indicators
Regime:
NF SS TF U
Quality:
A
B
C
all depths
© (2008) World Stress Map
40°
35°
30°
25°
36°
42°
48°
54°
60°
Projection: Mercator
World Stress Map Rel. 2008
Helmholtz Centre Potsdam
GFZ German Research Centre for Geosciences

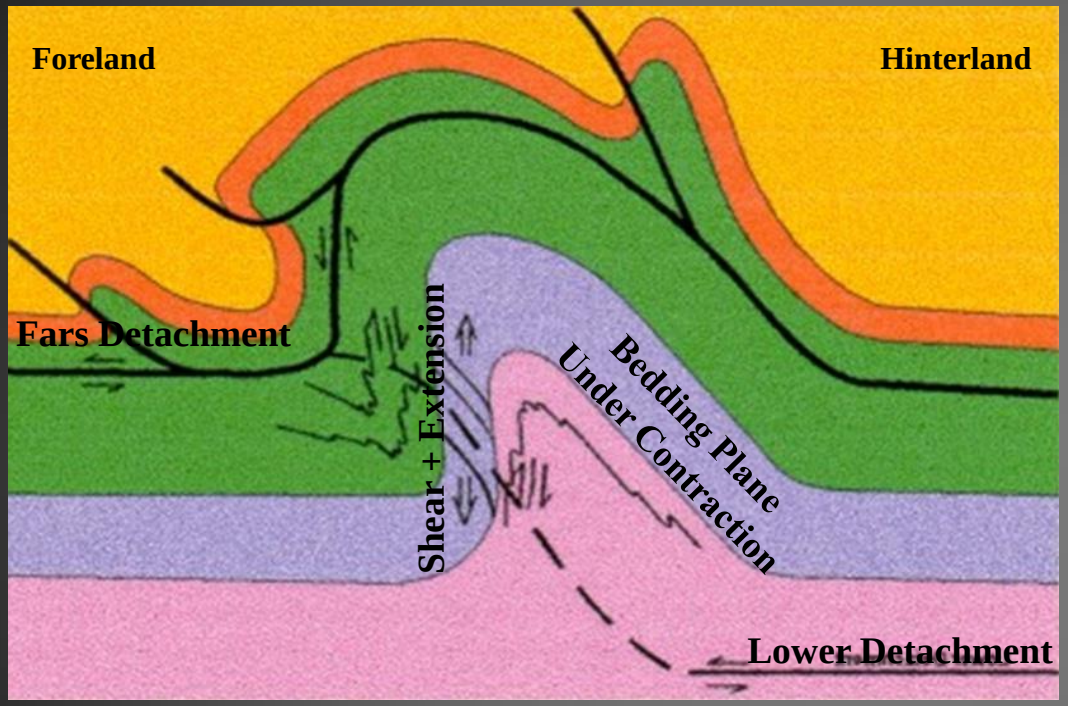

Foreland
Hinterland
Basal Fars Detachment
Crest
Hinge
Fars
Upper Tertiary
Siliciclastics
Pila
Spi
Gercus
Contains multiple
detachments
Lower Tertiary
Carbonates
P. MacKay, 2009

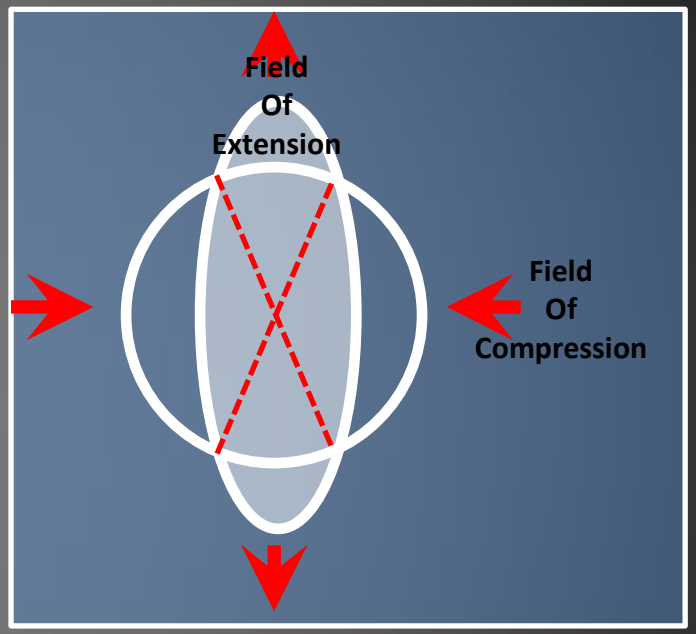


Intense deformation in core of fold

Shear on west-dipping forelimb – west limb



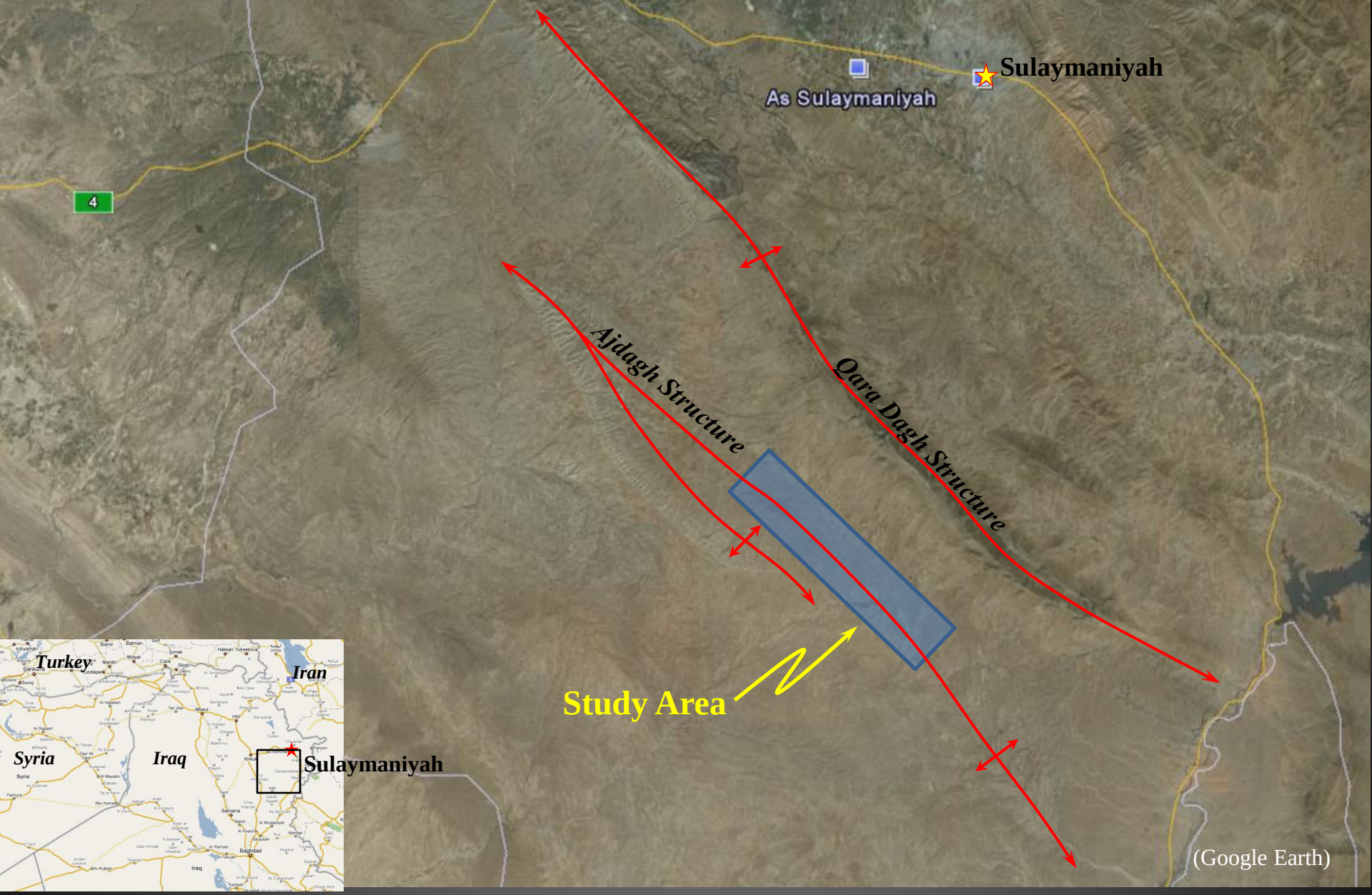


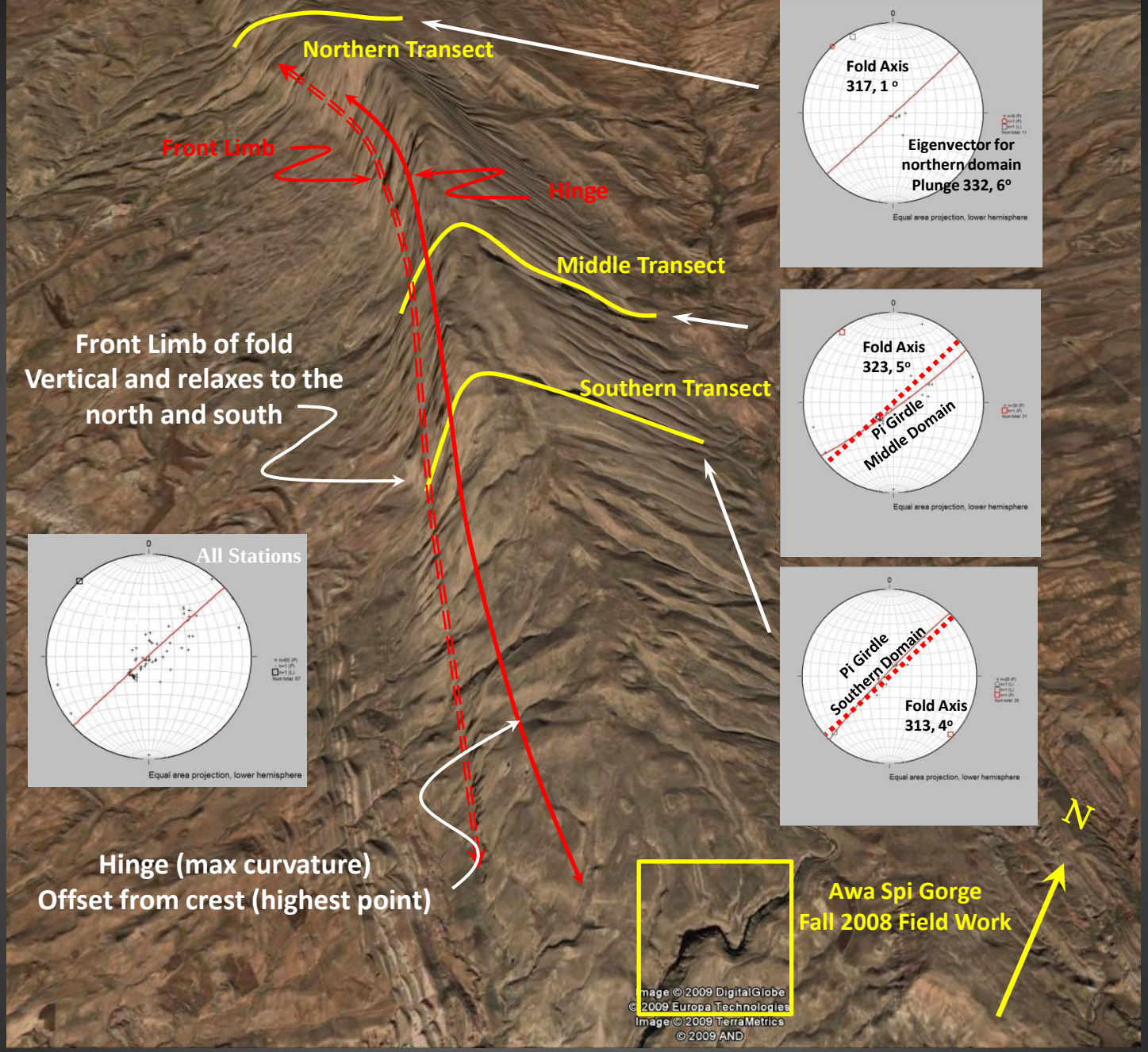


Rotation of fold limbs carry bedding from field of compression into field of extension

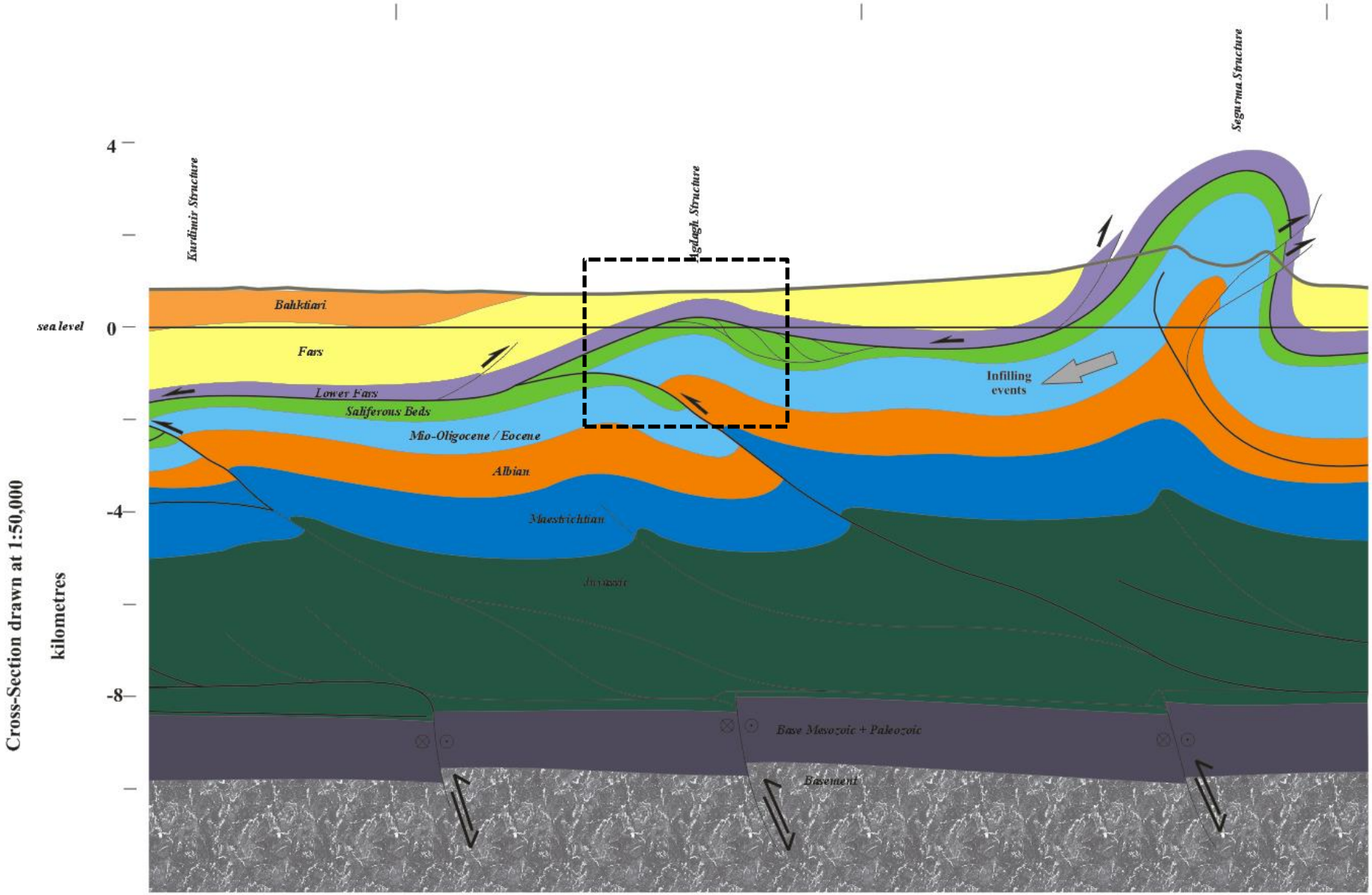
Structural Style

- Detachment Folds are the dominant structural style
- Minor small displacement faults
- Core of fold intensely deformed
- Large amplitude folds with:
  - Steep forelimb with bedding parallel shear
  - Over-thickened intensely fractured hinge
  - Intact back limb

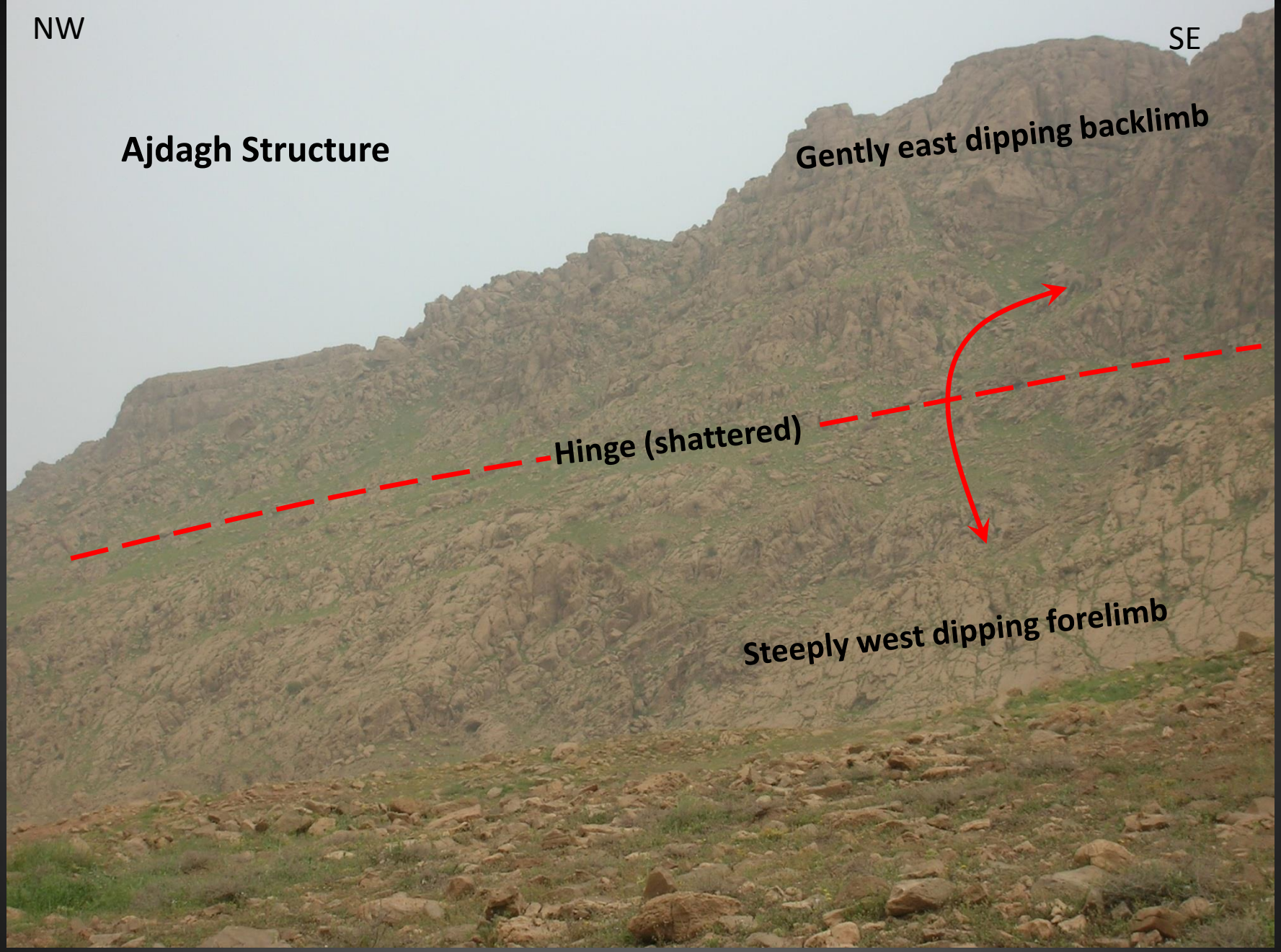

Sulaymaniyah
As Sulaymaniyah
4
Ajdagh Structure
Qara Dagh Structure
Study Area
Turkey
Iran
Syria
Iraq
Sulaymaniyah
(Google Earth)



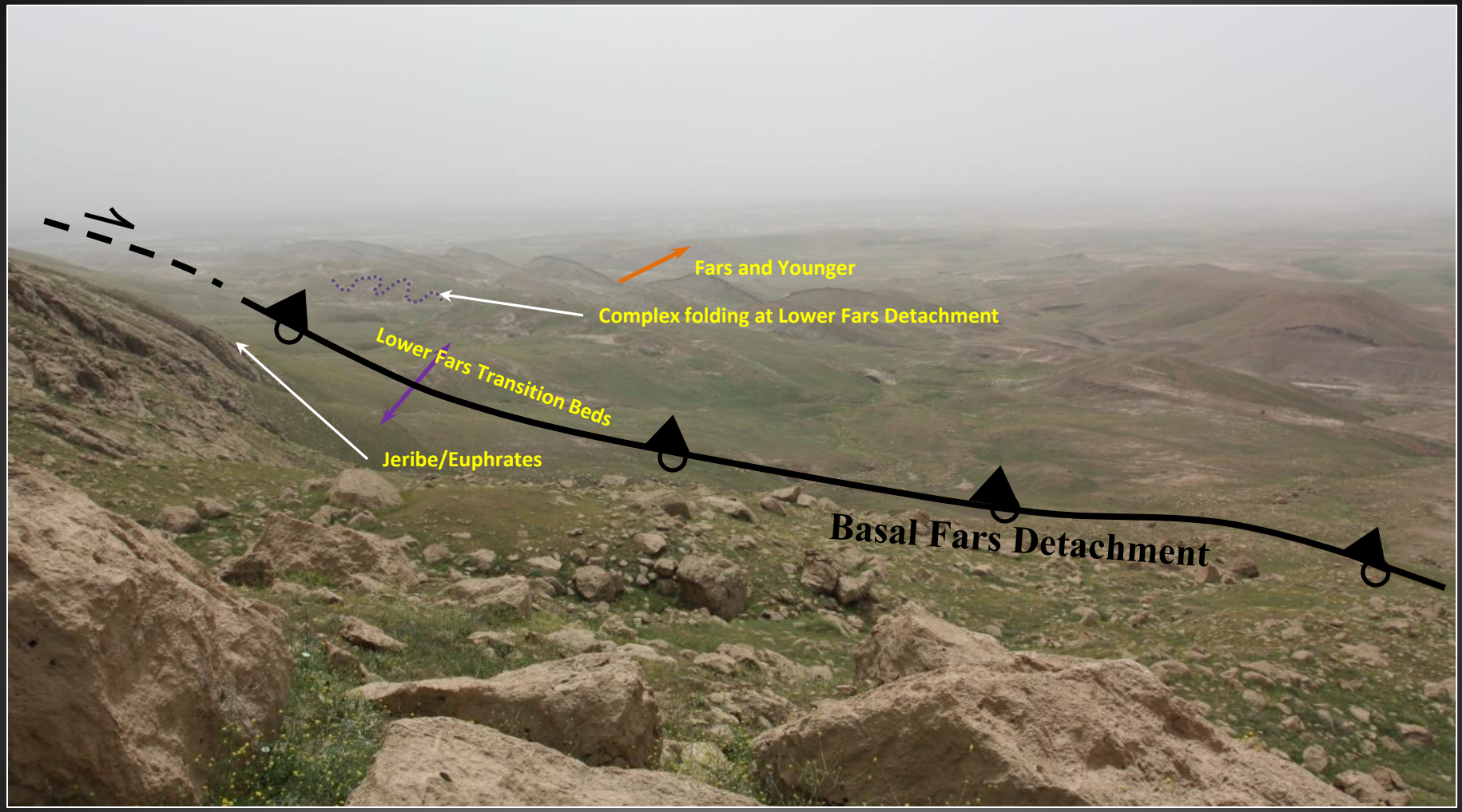
Inclined Google Earth image looking northwest along the Ajdagh Structure; Poles to bedding



A portion of the regional cross-section through the Ajdagh Structure.



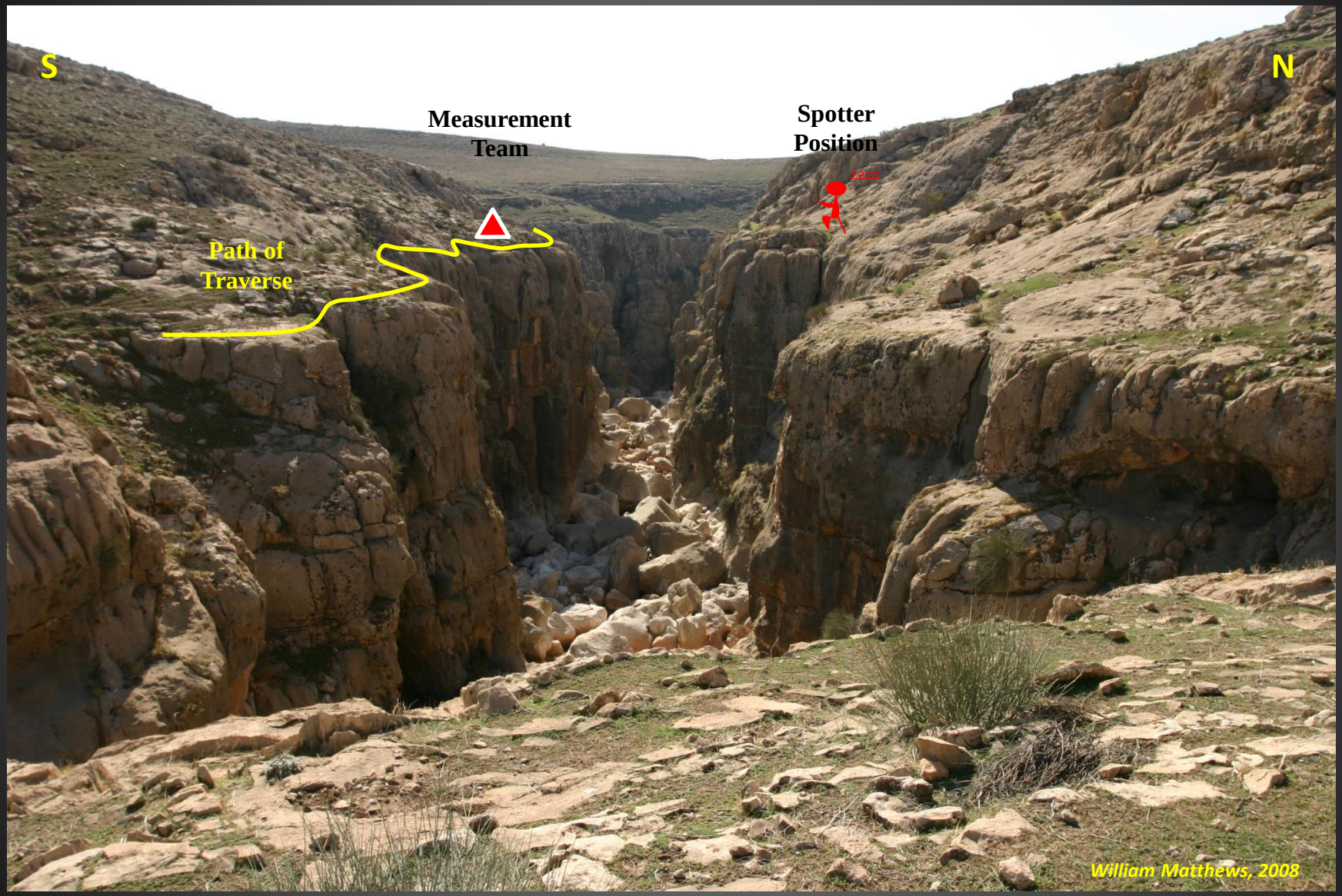
Looking northeast at the front limb and hinge of the Ajdagh Structure



Regional detachment at the base of the Fars.
Looking south along the front limb of the Ajdagh Structure

Google Earth image of Awa Spi Gorge showing position of fracture sample traverses.

Fracture Study – Ajdagh Anticline

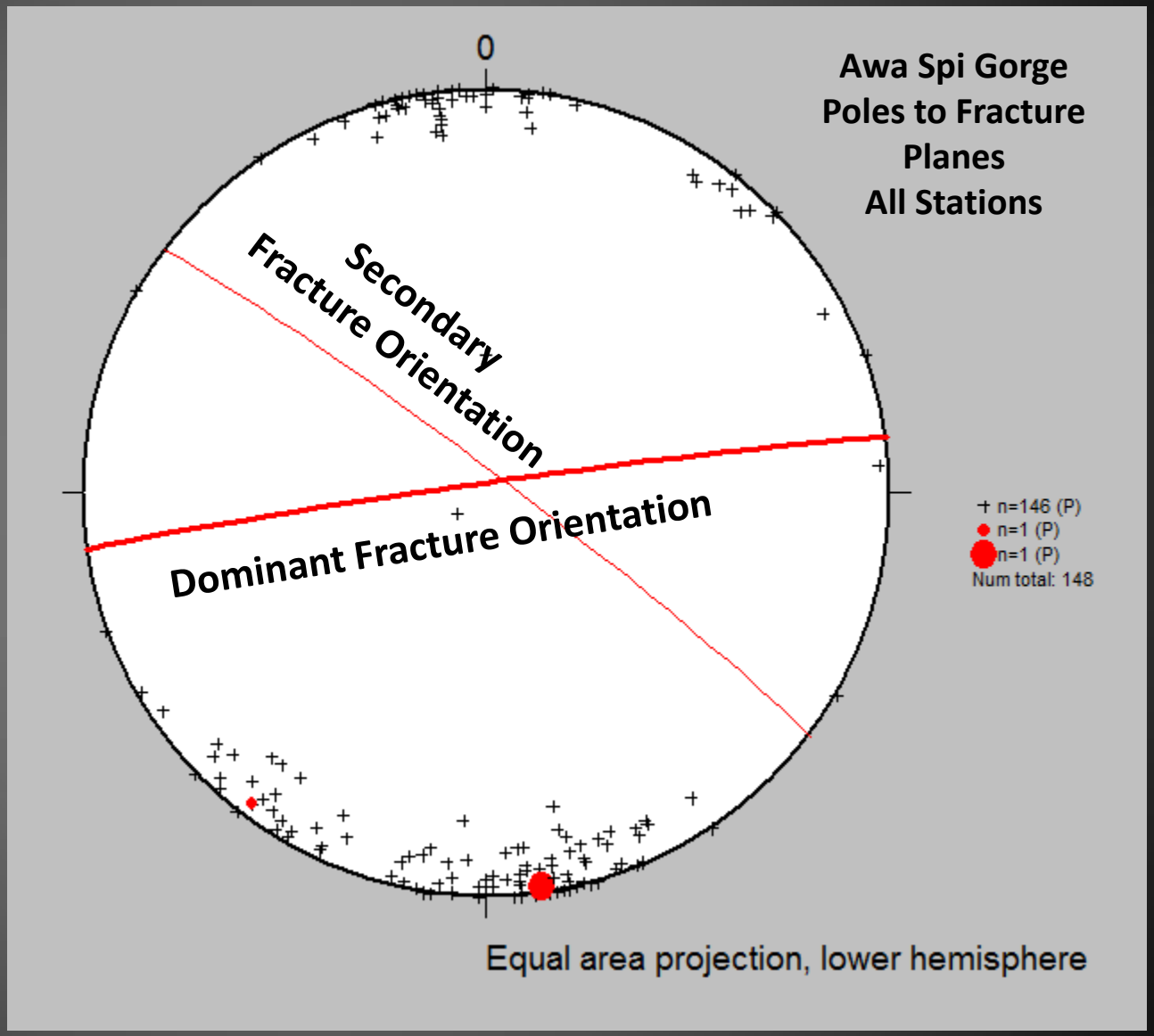


Technique used for sampling fracture systems.

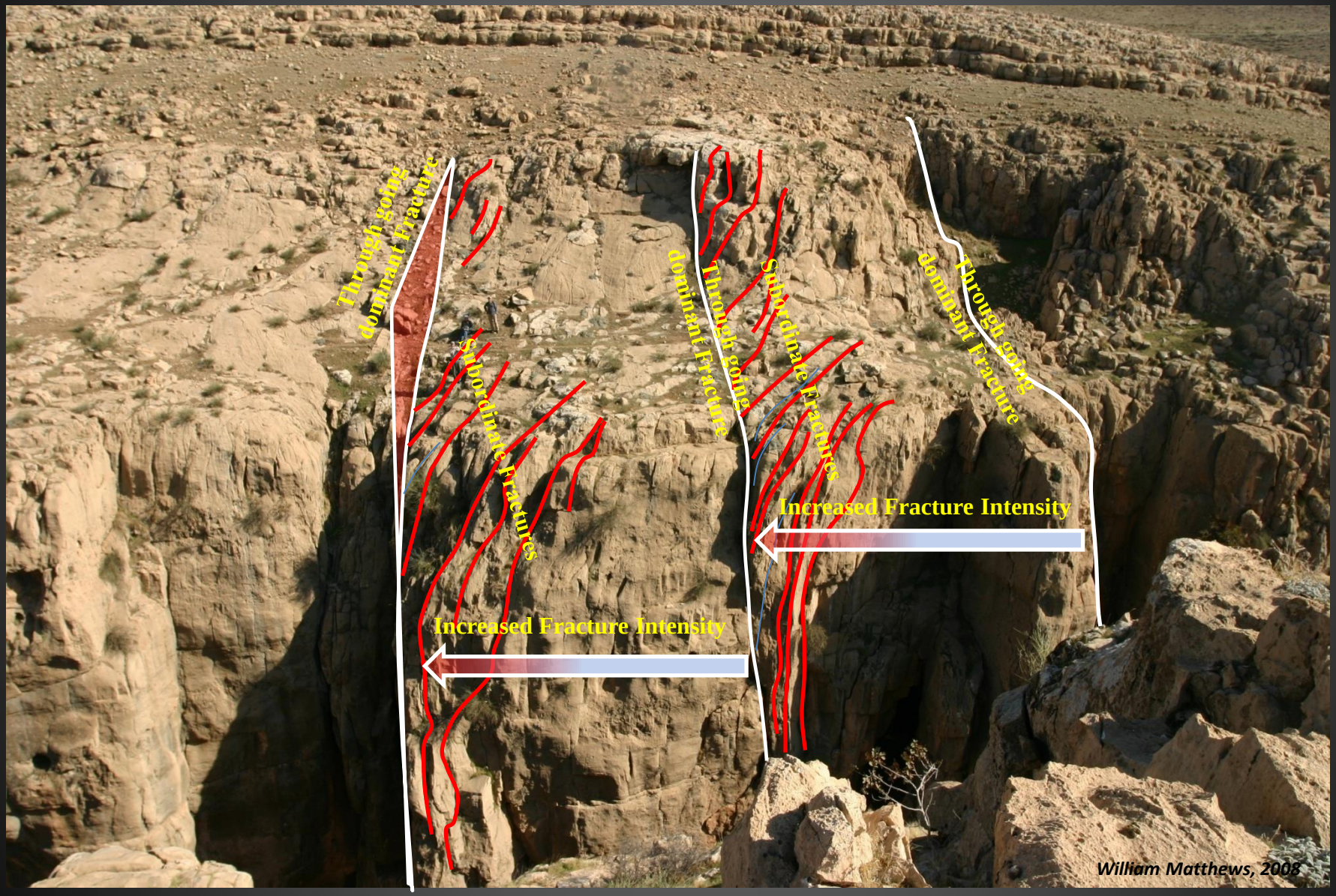
Awa Spi Gorge

Ajdagh Anticline

- Fractures dominantly perpendicular to bedding
- Two dominant sets of fractures

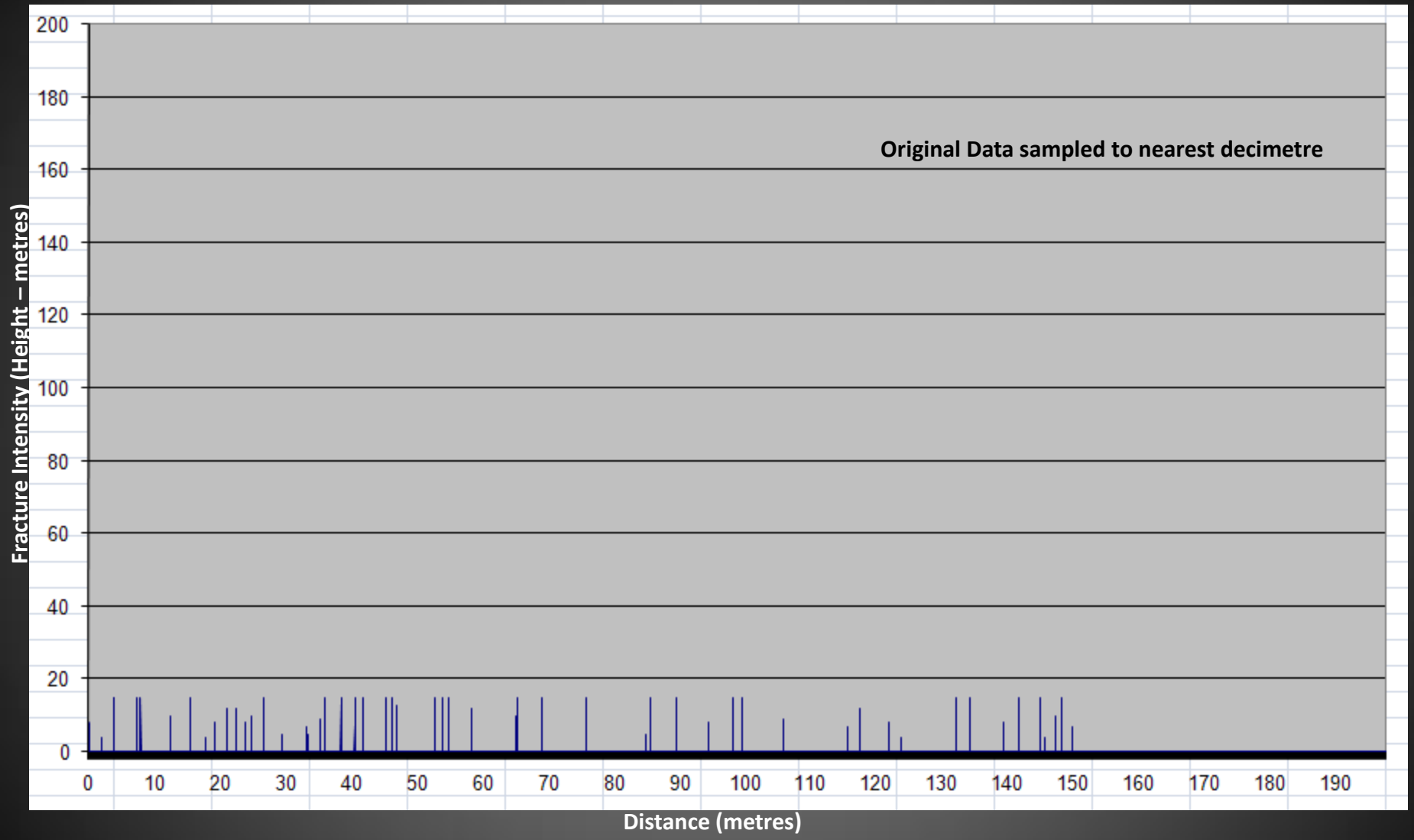


Fracture Study – Awa Spi Gorge



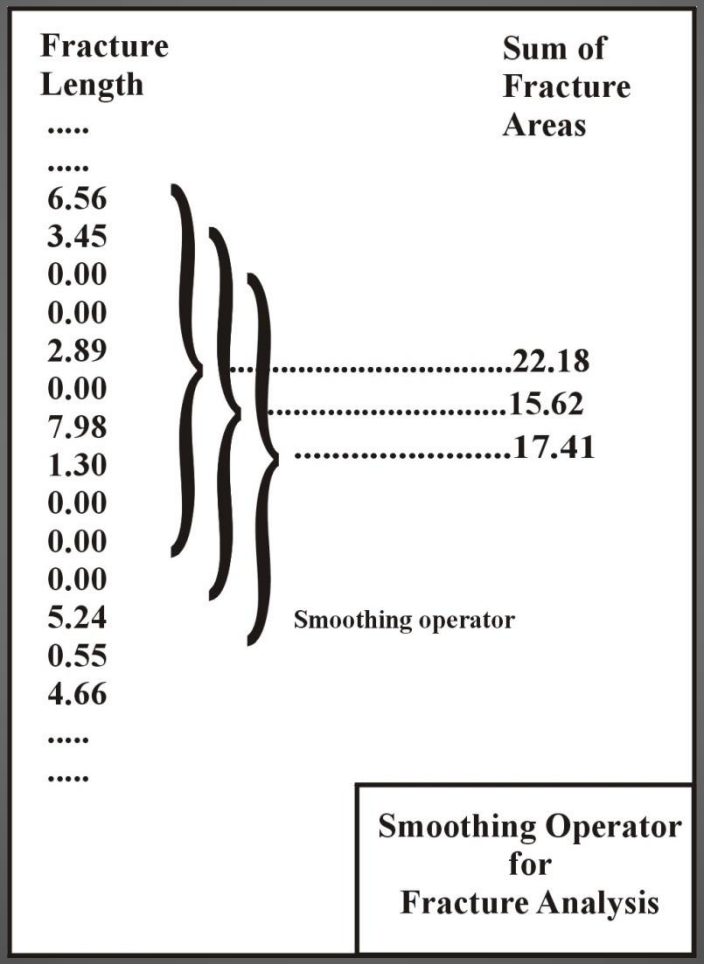
Fracture systems along the Awa Spi Gorge.

Ajdagh Anticline Traverse #1



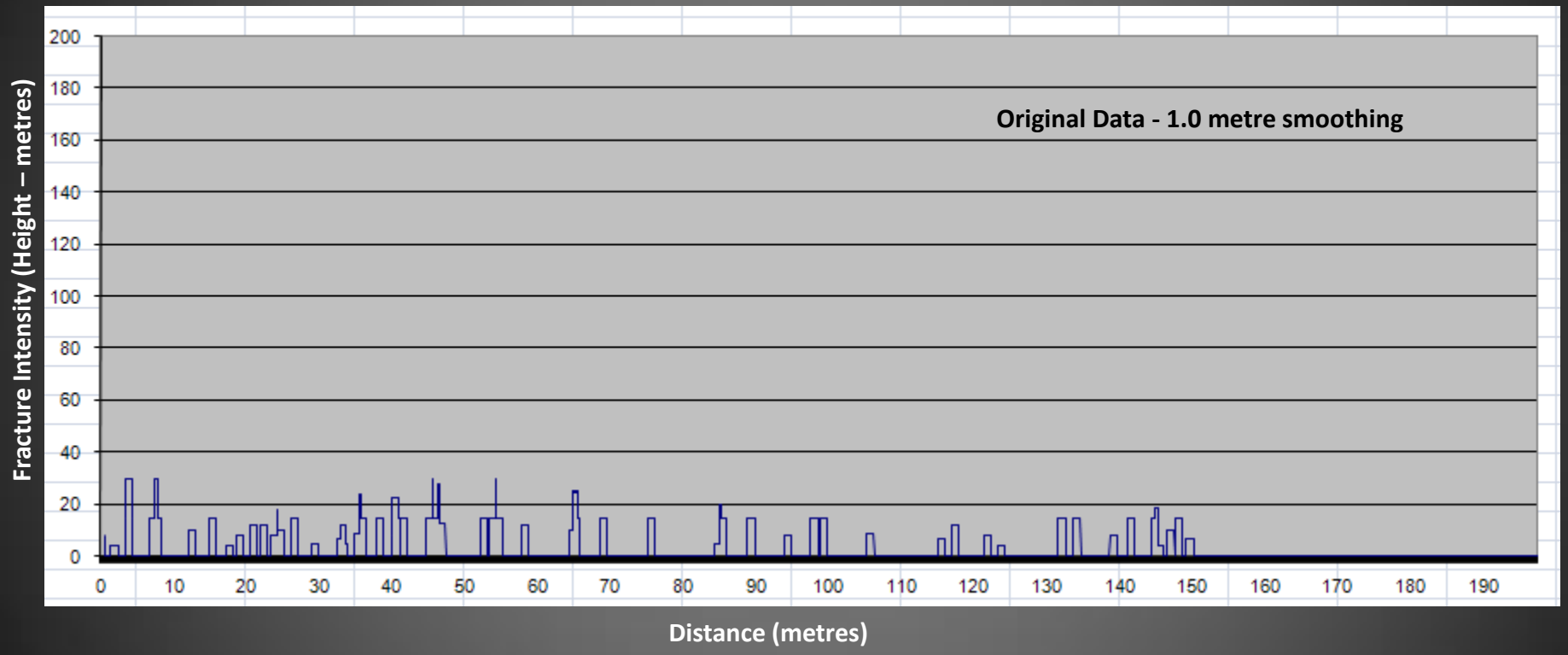
Fracture height vs. Distance – Traverse #1

Summing Algorithm



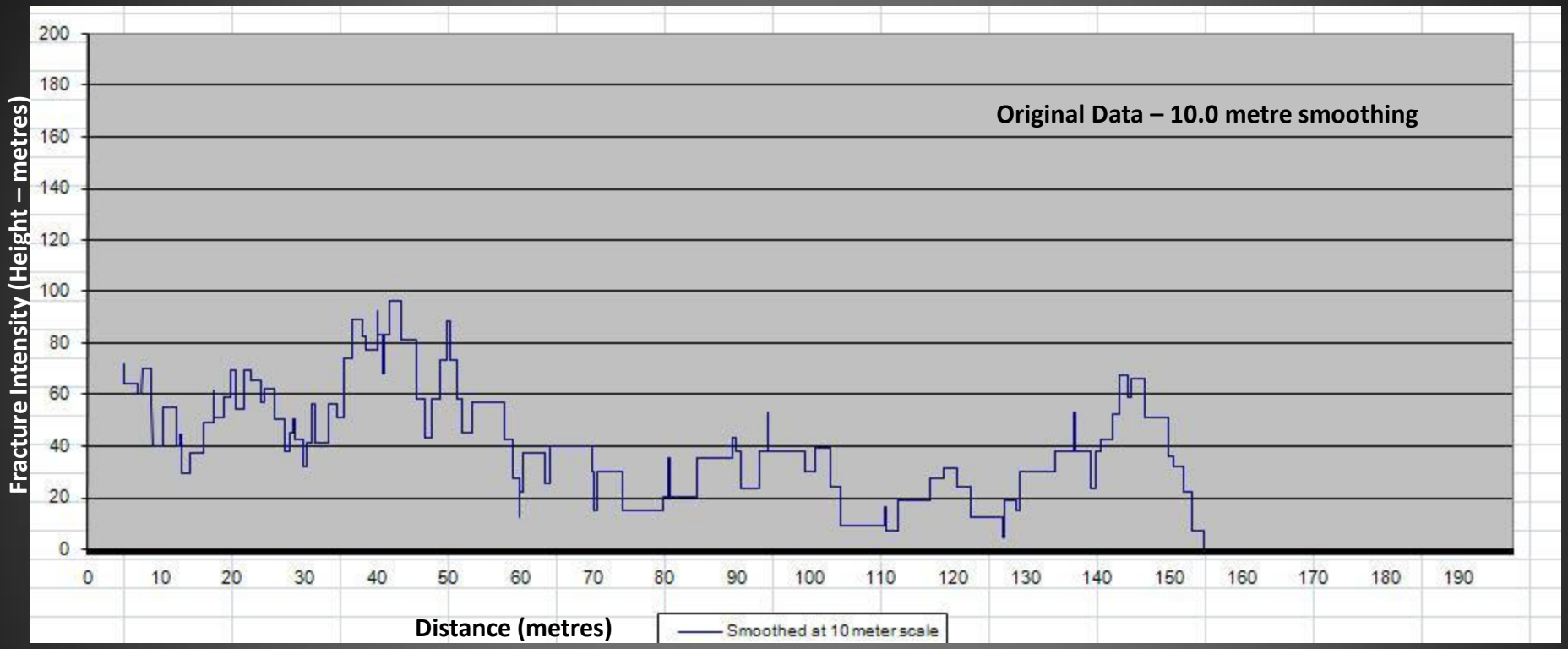
Technique for summing fractures

Ajdagh Anticline Traverse #1

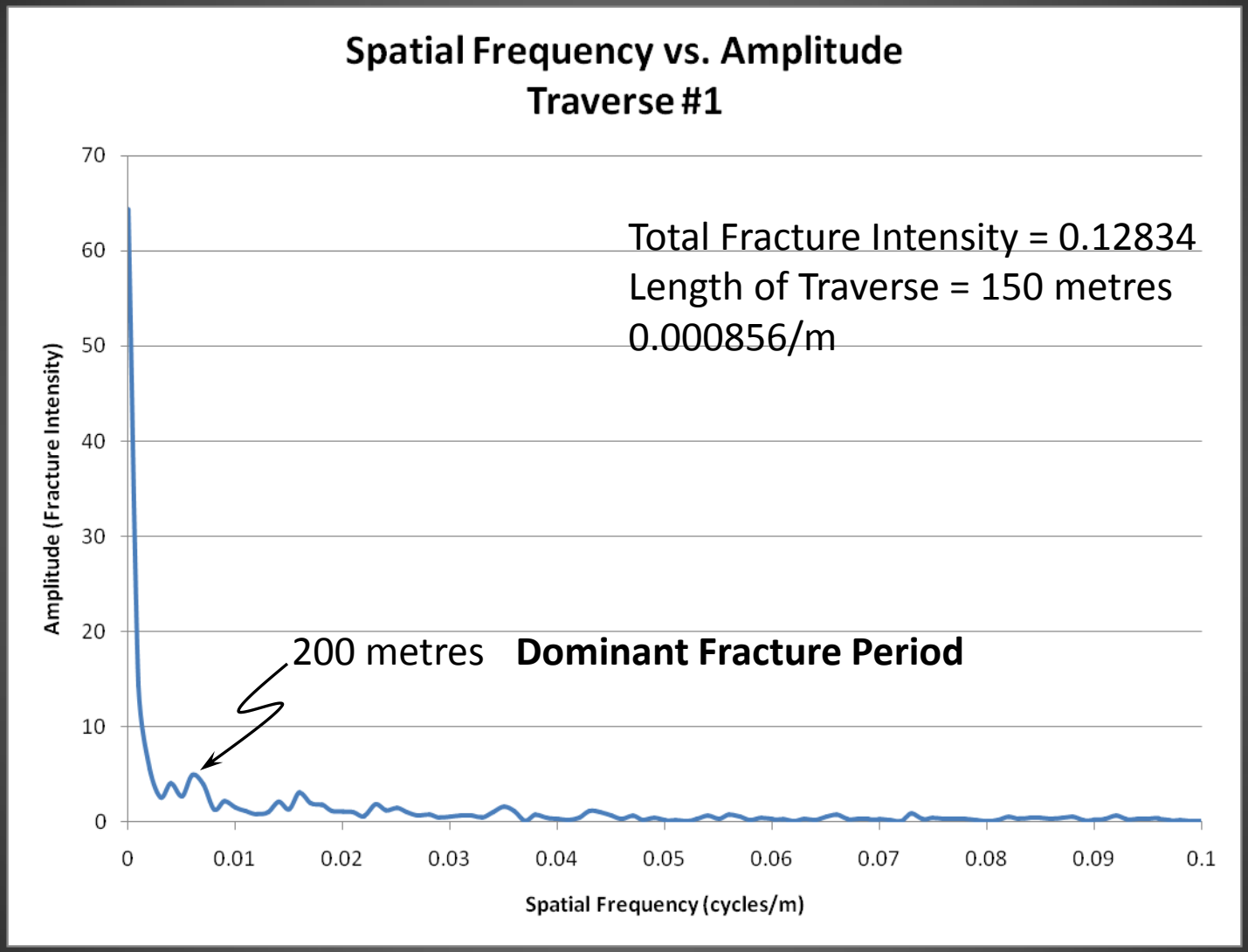


Fracture height vs. Distance – Traverse #1 – 1.0 metre summing

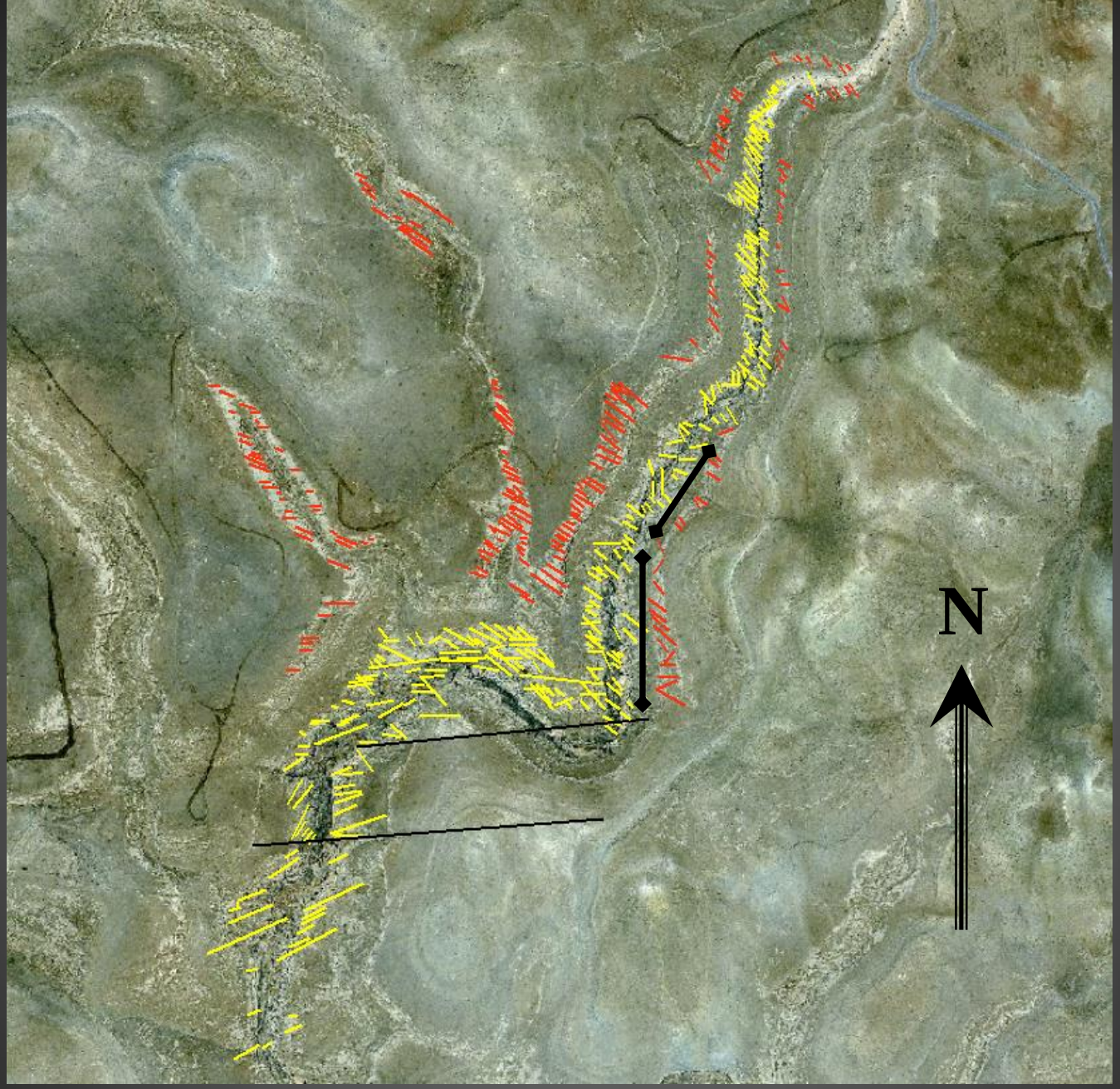
Ajdagh Anticline Traverse #1



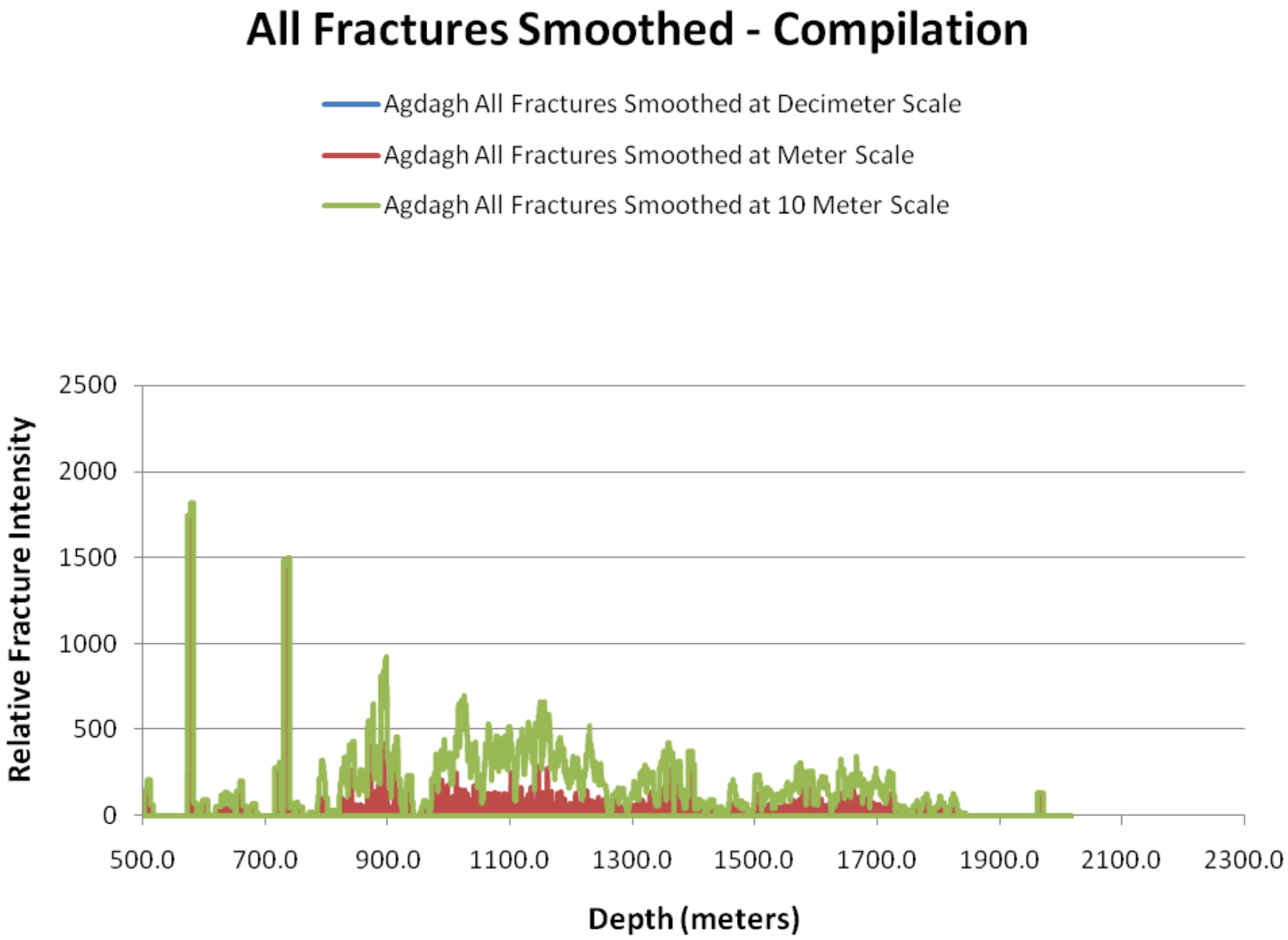
Fracture height vs. Distance – Traverse #1 – 10.0 metre summing



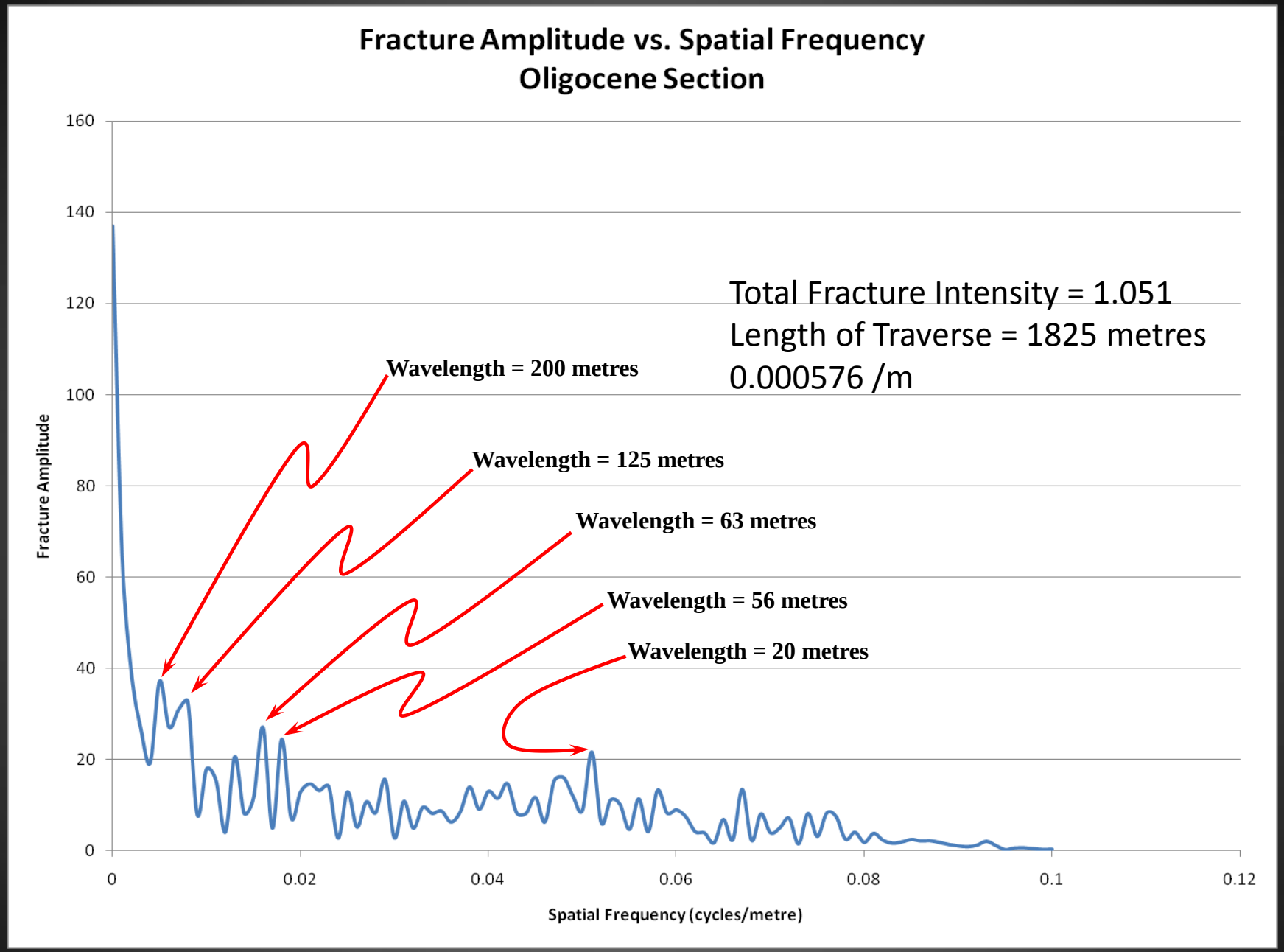
FFT of Fracture distribution – Travers #1 – Awa Spi Gorge



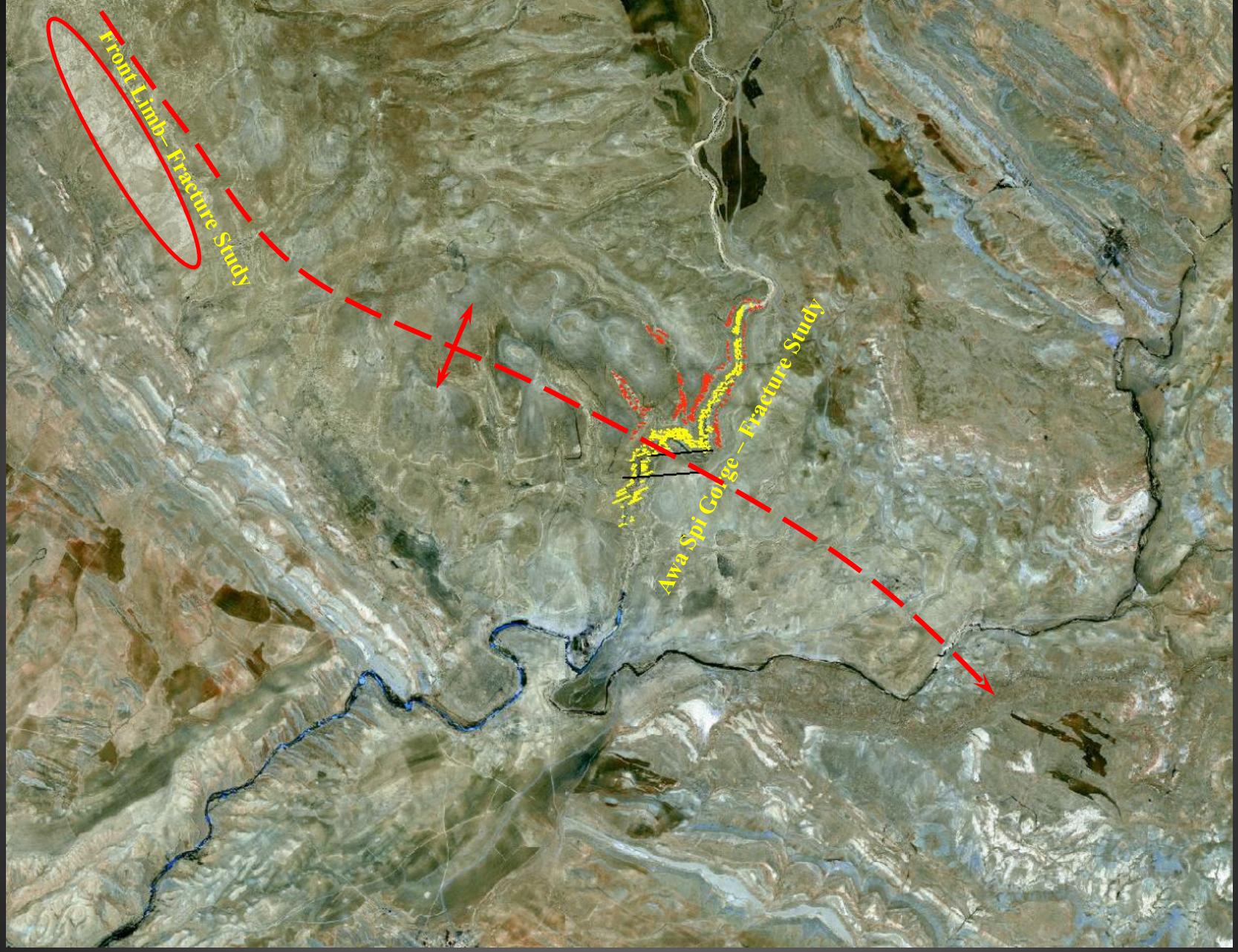
QuickBird Satellite data –Awa Spi Gorge



Fracture height vs. Distance – QuickBird Data



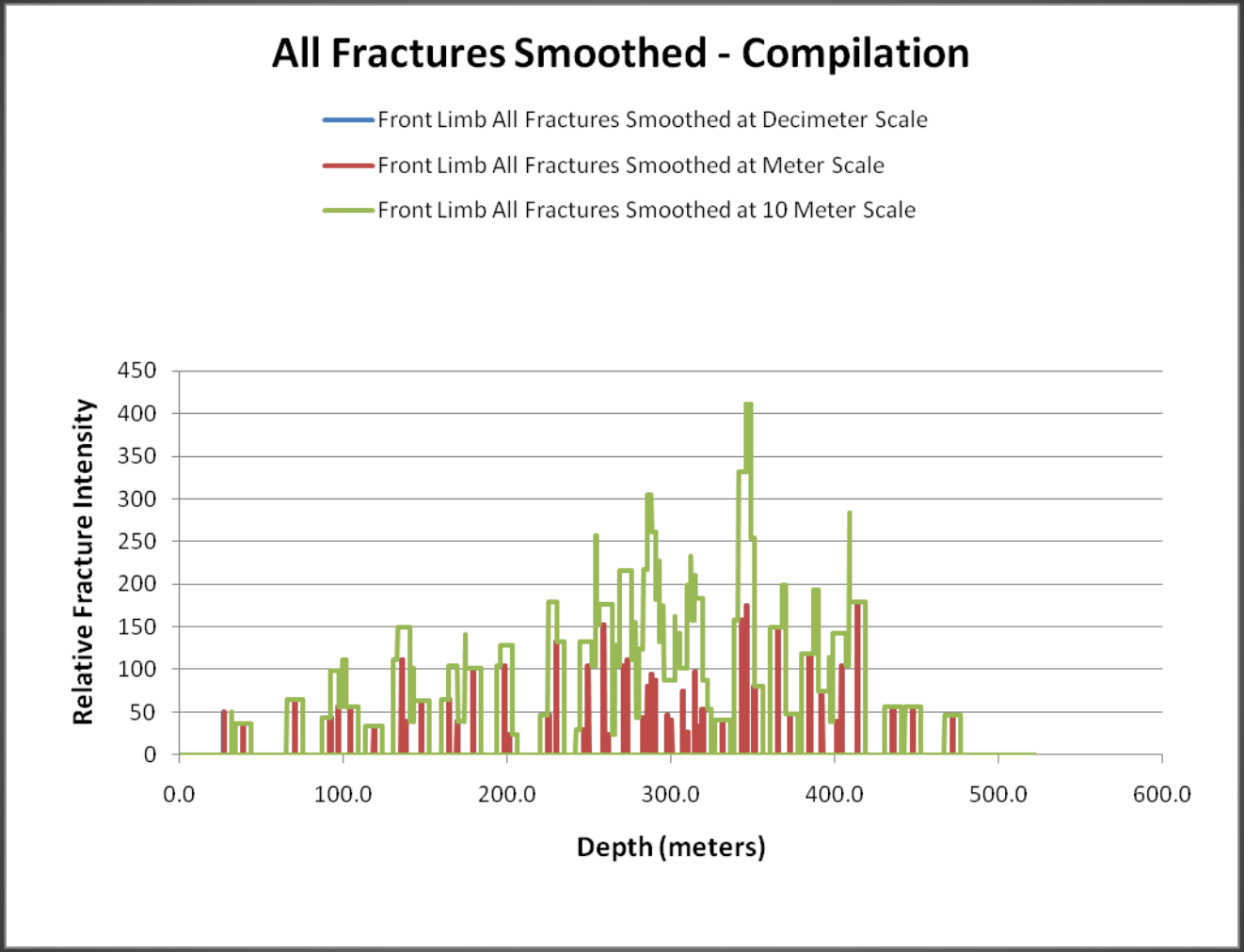
FFT of Fracture distribution – Oligocene Section



QuickBird Satellite data –Ajdagh Anticline

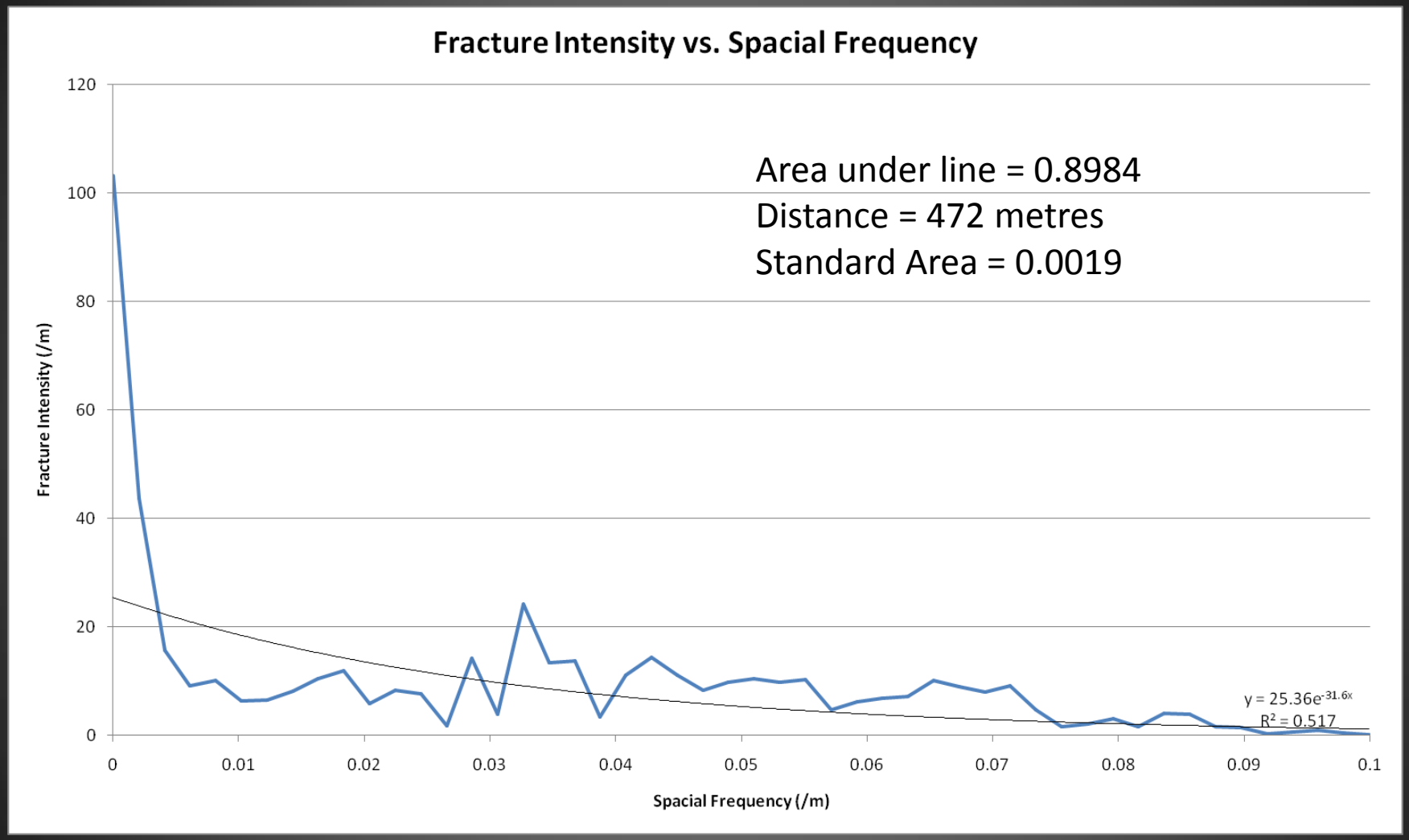
Close-up of QuickBird Data
Front Limb – Ajdagh Anticline

Ajdagh Fracture Study – Front Limb

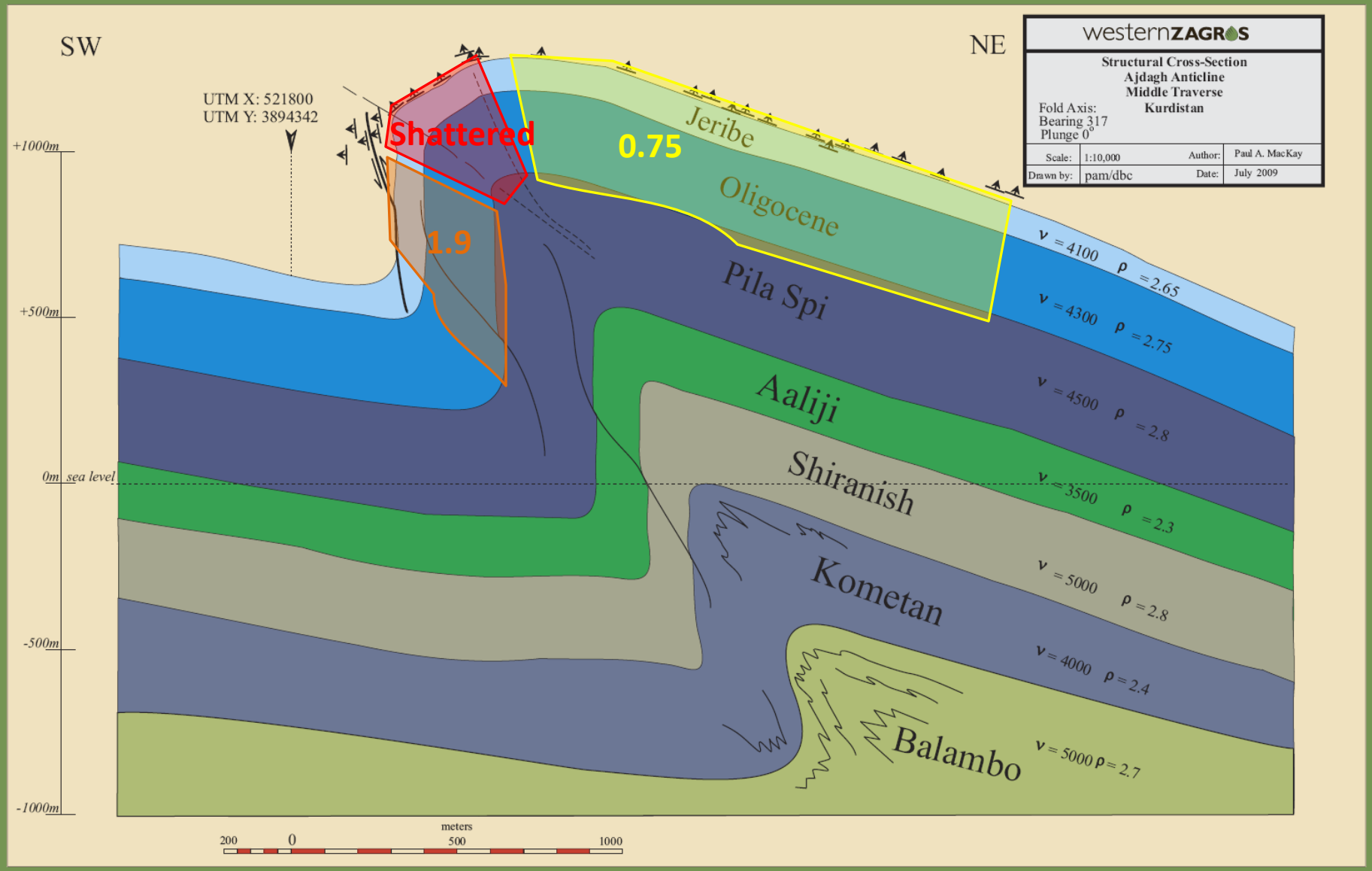


Fracture height vs. Distance – QuickBird Data – All summing curves – front limb

Ajdagh Fracture Study – Front Limb



FFT of Fracture distribution – Front Limb – Ajdagh Anticline



Cross-Section of the Ajdagh Structure based on field measurements. Fracture Intensity from FFT Analysis overprinted

Conclusions

- Kurdistan Region of Iraq has excellent outcrops for the study of fractured reservoirs
- Fracture intensity is affected by structural position
- FFT is useful for quantitatively estimate fracture intensity
- Fracture Intensity is a measure of strain within the rock
- FFT Results can be incorporated directly into reservoir models and simulations
- There are many subsurface applications to analyze Fracture Systems using FFT

Presented with the kind permission of the Kurdish Regional Government, WesternZagros Resources Ltd. and Talisman Energy

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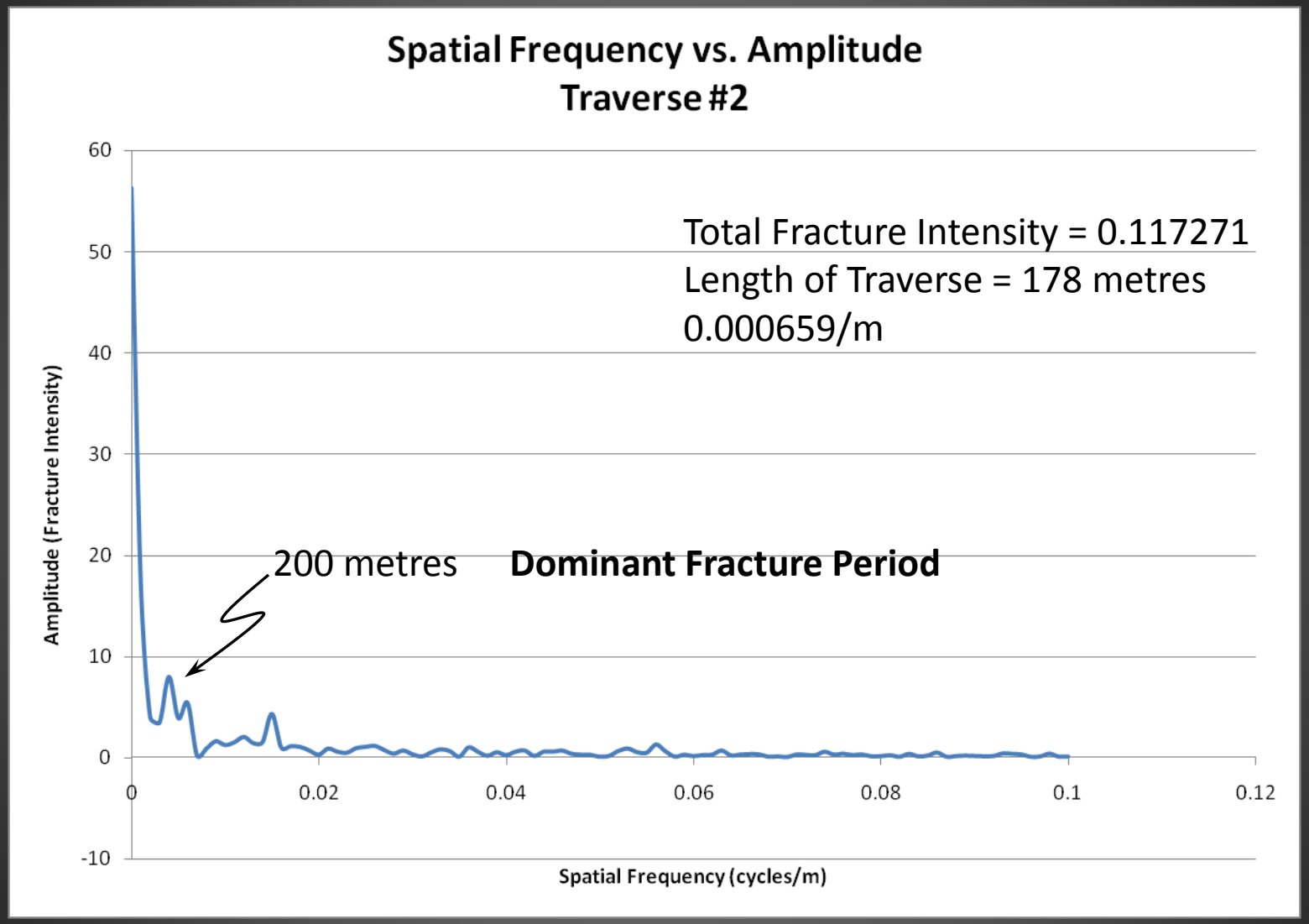
Thanks to Dr. Dler Baban Dr Fadhil Lawa, and Mr. Jeba



FFT of Fracture distribution – Travers #2 – Awa Spi Gorge

TURKEY
SYRIA
IRAN
JORDAN
Study Area
Zagros Mountains
Caspian Sea
Lake Urmia
Adıyaman
Diyarbakır
Batman
Kurtalan
Şanlıurfa
Viranşehir
Mardin
Al Qāmishlī
Cizre
Hakkari
Zakho
DAHŪK
Dahūk
'Aqrah
Buḥayrat Dahūk
Al Ḥasakah
Sinjār
Tall 'Afar
Mosul
ARBĪL
Arbīl
Buḥayrat Dokan
Ar Raqqah
NĪNAWÁ
Dayr az Zawr
Nahr al Khābūr
Euphrates
Tigris
Zab
Lesser Zab
Kirkuk
AT TA'MĪM
AS SULAYMĀNĪYAH
As Sulaymāniyah
Halabjah
Bayjī
Tikrīt
ṢALĀḤ AD DĪN
Buḥayrat al Qādisiyah
Buḥayrat ath Tharthār
Al Qa'im
Ḥadīthah
Sāmarrā'
Buḥayrat Diyālá
Khānaqīn
Diyala
DIYALÁ
Mandalī
Ba'qūbah
'Akāshāt
AL ANBĀR
Hīt
Ar Ramādī
Al Fallūjah
Baghdad
Al Ḥabbāniyah
Buḥayrat al Ḥabbāniyah
BAGHDAD
Ar Ruṭbah
alignment approximate
Buḥayrat ar Razāzah
Karbalā'
BĀBIL
Al Ḥillah
Al Hindiyah
KARBALĀ'
WĀSIṬ
Al Kūt
An Nukhayb
An Najaf
Ad Dīwāniyah
AL QĀDISIYAH
Al Ḥayy
MAYSĀN
Al Amārah
Dezfūl
Khorramābād
Borujerd
Īlām
Kermānshāh
Hamadān
Sanandaj
Saqqez
Mahābād
Drumiyeh
Marāgheh
Mīāneh
Zanjān
Tabrīz
Ardabīl

Awa Spi Gorge - Ajdagh Anticline

Intense deformation in core of fold