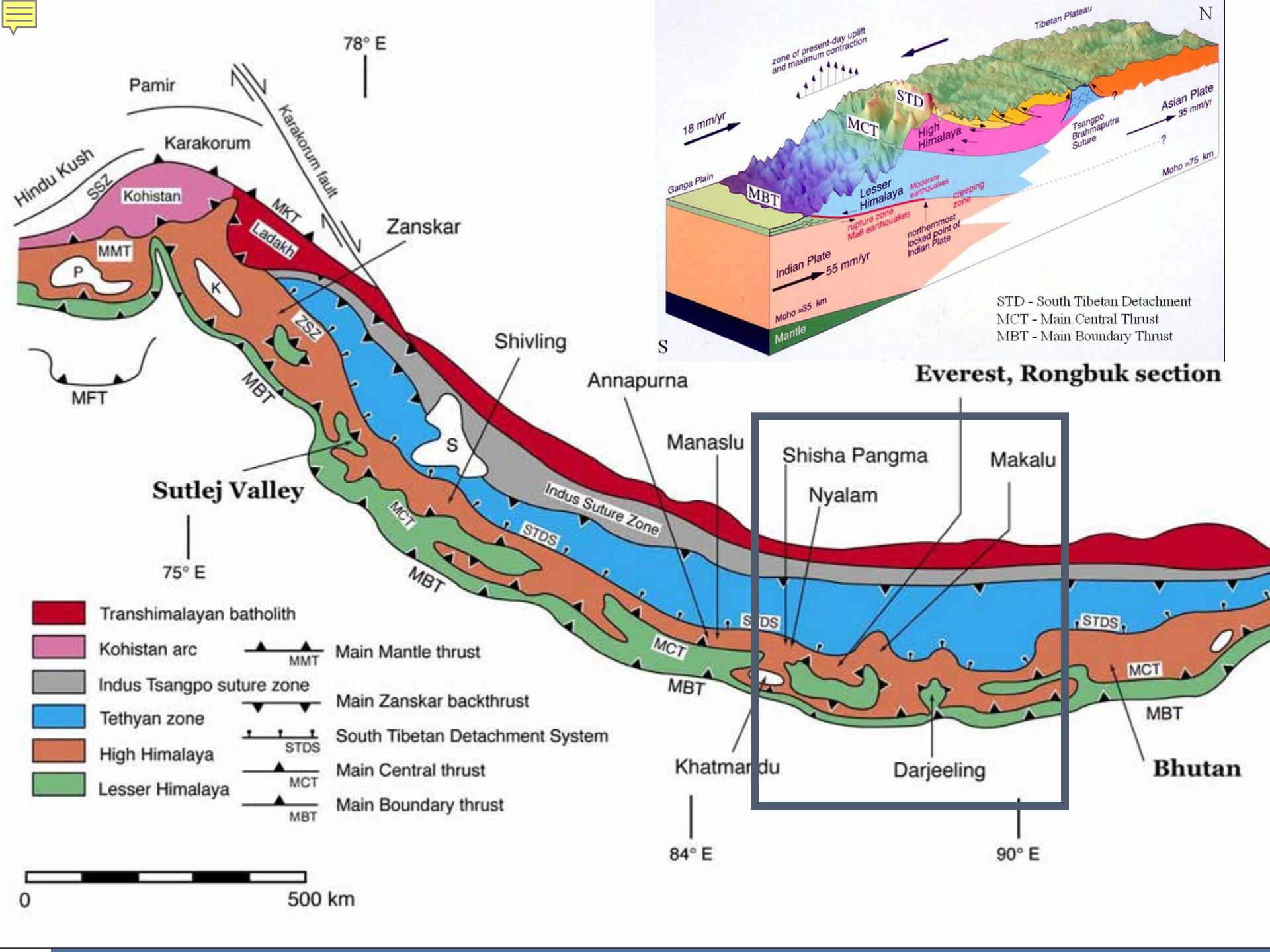
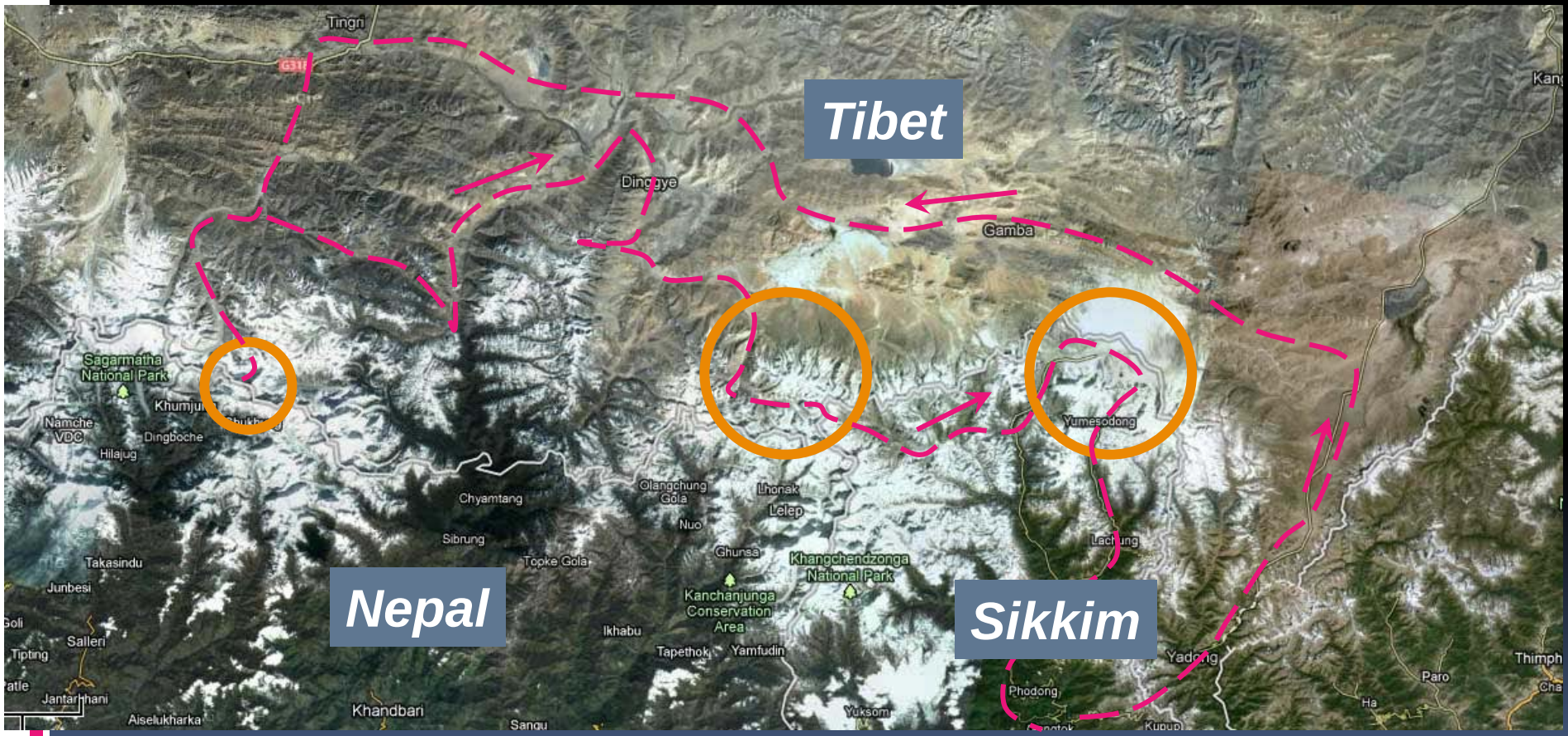
Some early observations of High Himalayan geology

WAGER AND THE SOUTH TIBETAN DETACHMENT SYSTEM


78° E
Pamir
Karakorum fault
Karakorum
Hindu Kush
SSZ
Kohistan
MKT
Ladakh
Zanskar
MMT
P
K
ZSZ
MFT
MBT
Shivling
S
Sutlej Valley
75° E
Annapurna
Manaslu
Indus Suture Zone
STDS
MCT
MBT
Everest, Rongbuk section
Shisha Pangma
Nyalam
Makalu
Khatmandu
Darjeeling
Bhutan
84° E
90° E
Transhimalayan batholith
Kohistan arc
Indus Tsangpo suture zone
Tethyan zone
High Himalaya
Lesser Himalaya
Main Mantle thrust
Main Zanskar backthrust
South Tibetan Detachment System
Main Central thrust
Main Boundary thrust
0
500 km
N
S
Tibetan Plateau
zone of present-day uplift and maximum contraction
18 mm/yr
STD
MCT
High Himalaya
Tsangpo Brahmaputra Suture
Asian Plate
35 mm/yr
Moho ≈75 km
Ganga Plain
MBT
Lesser Himalaya
Moderate earthquakes
creeping zone
rupture zone M≥8 earthquakes
northernmost locked point of Indian Plate
Indian Plate
55 mm/yr
Moho ≈35 km
Mantle
STD - South Tibetan Detachment
MCT - Main Central Thrust
MBT - Main Boundary Thrust

1933 expedition

Everest Lashar Valley Upper Lachen



Searle map

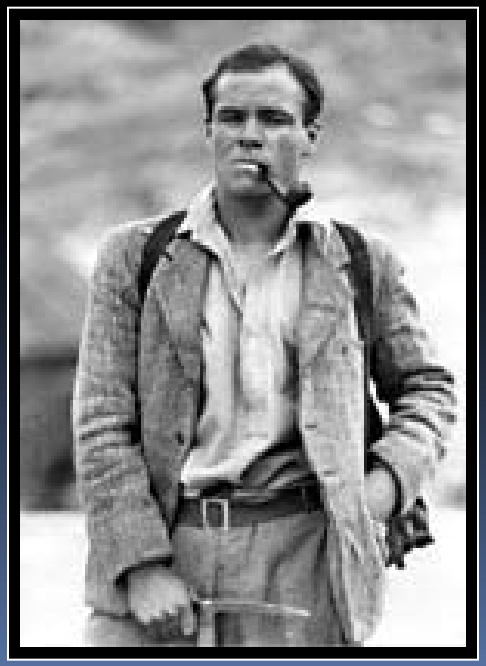
Tethyan limestone

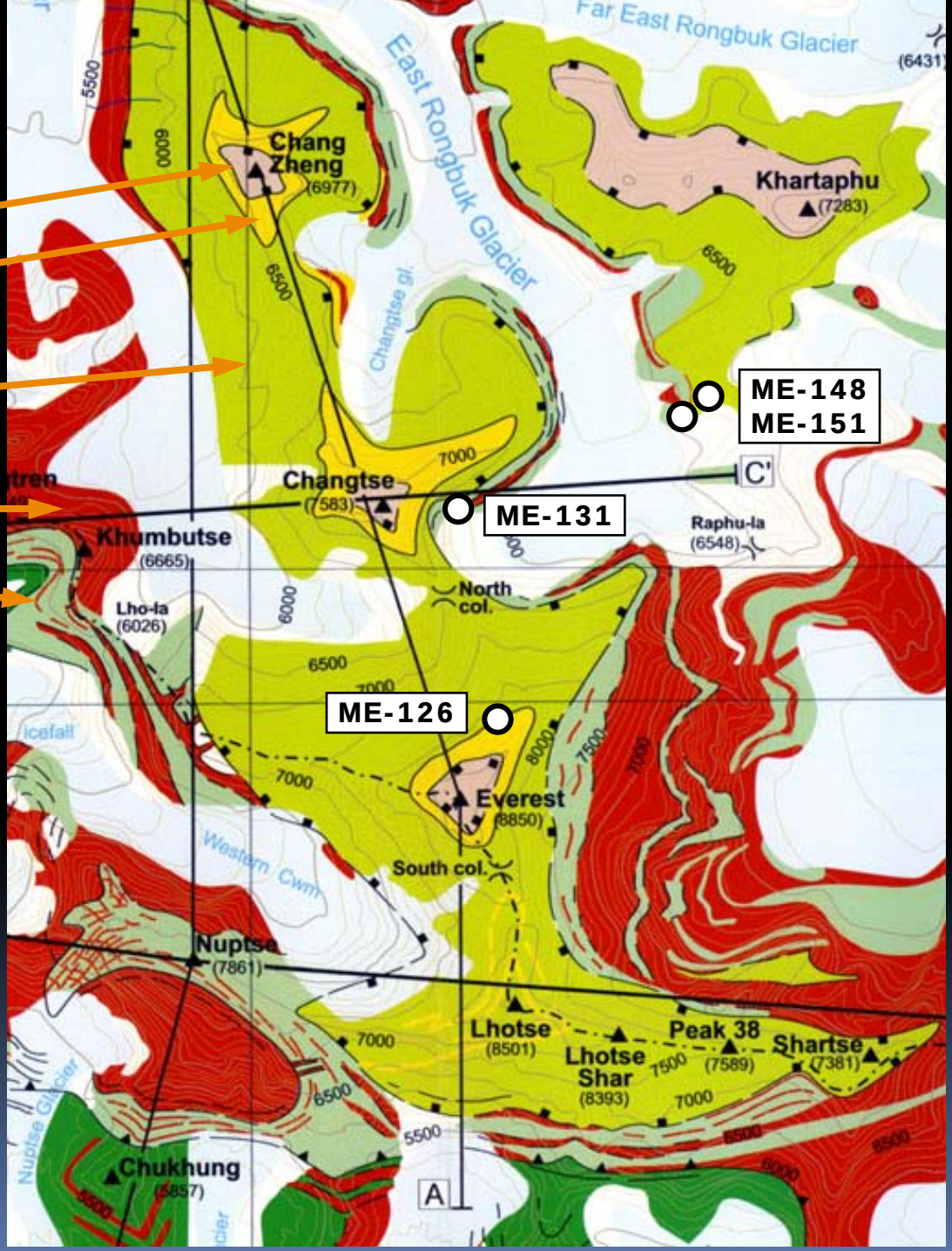
Yellow Band

Everest Series

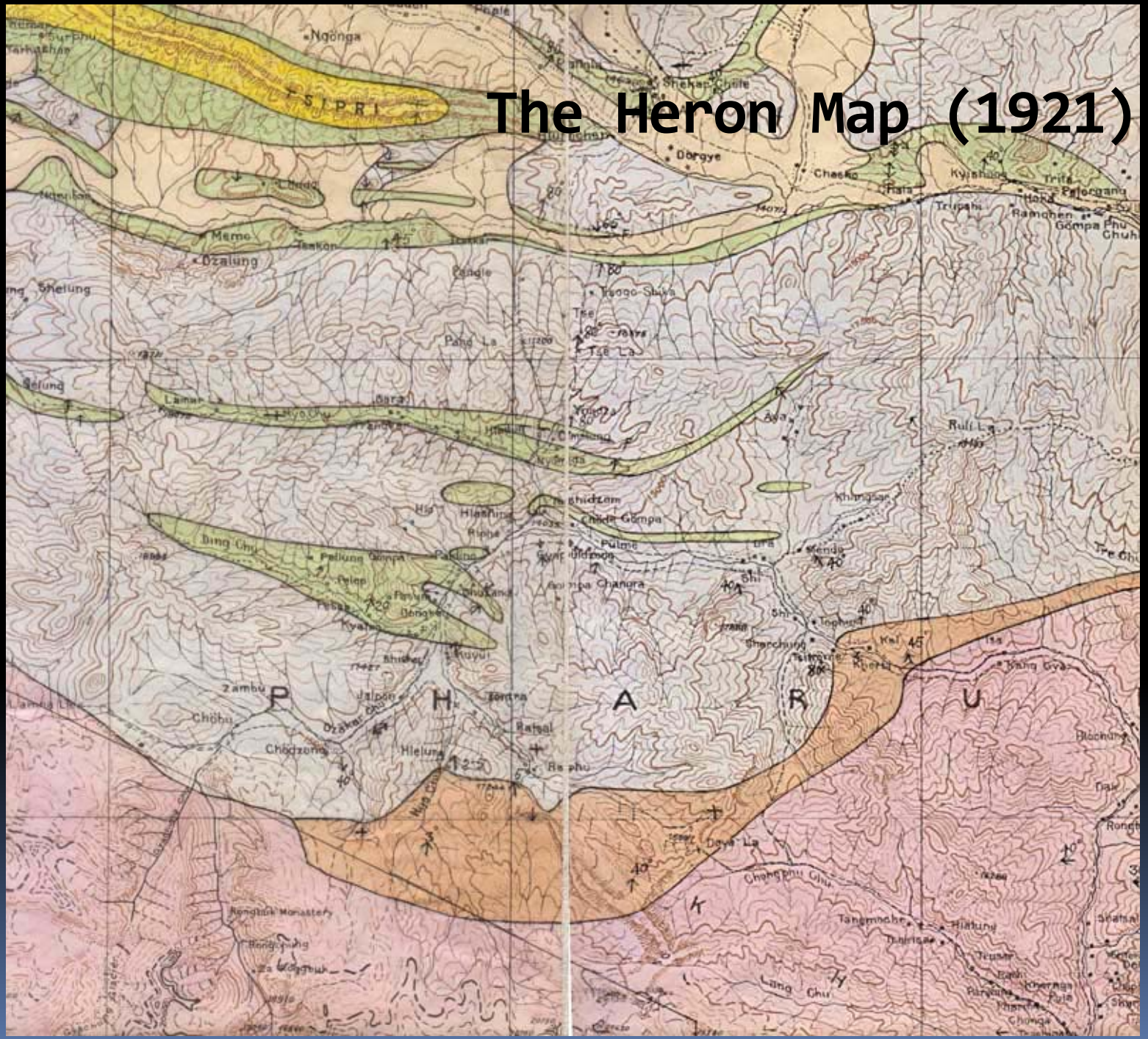
Leucogranite sheets

Greater Himalayan Series





The Heron Map (1921)



Wager's observations on Everest

- Upper Everest Limestone
  "… seems no more metamorphosed than the Carboniferous Lst of Yorkshire"
- Everest pelites
  "an injected and metamorphosed shale"
  "The injecting material was usually a schorl muscovite pegmatite of moderate coarseness. Sometimes a good deal foliated sometimes more aplitic … containing sporadic garnets"

Wager's observations on Everest

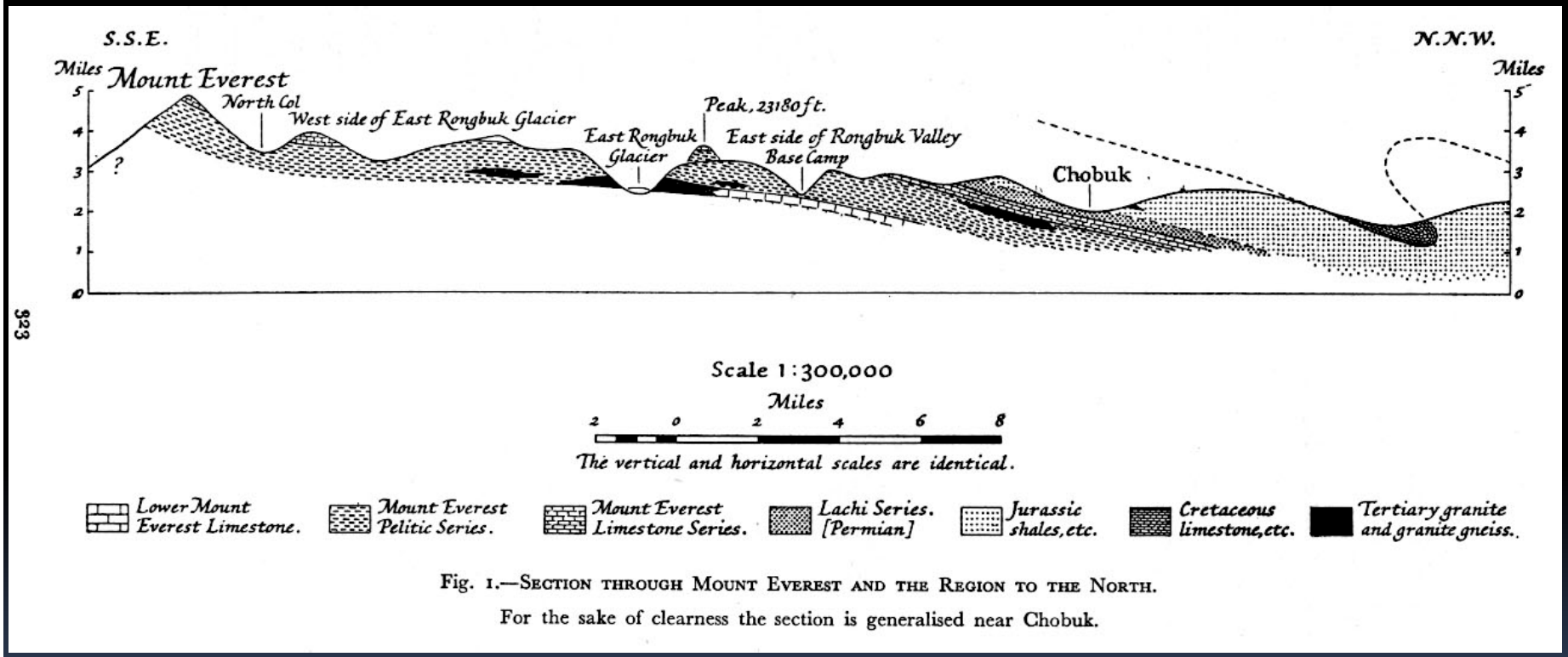


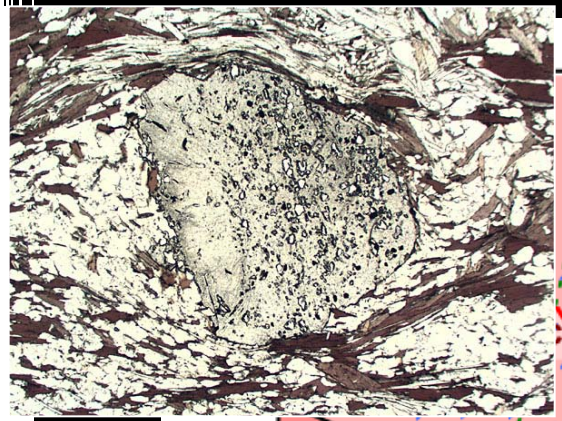
Fig. 1.—Section through Mount Everest and the Region to the North.

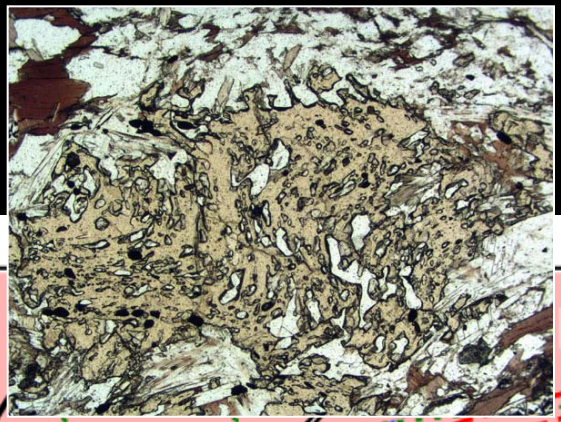
For the sake of clearness the section is generalised near Chobuk.

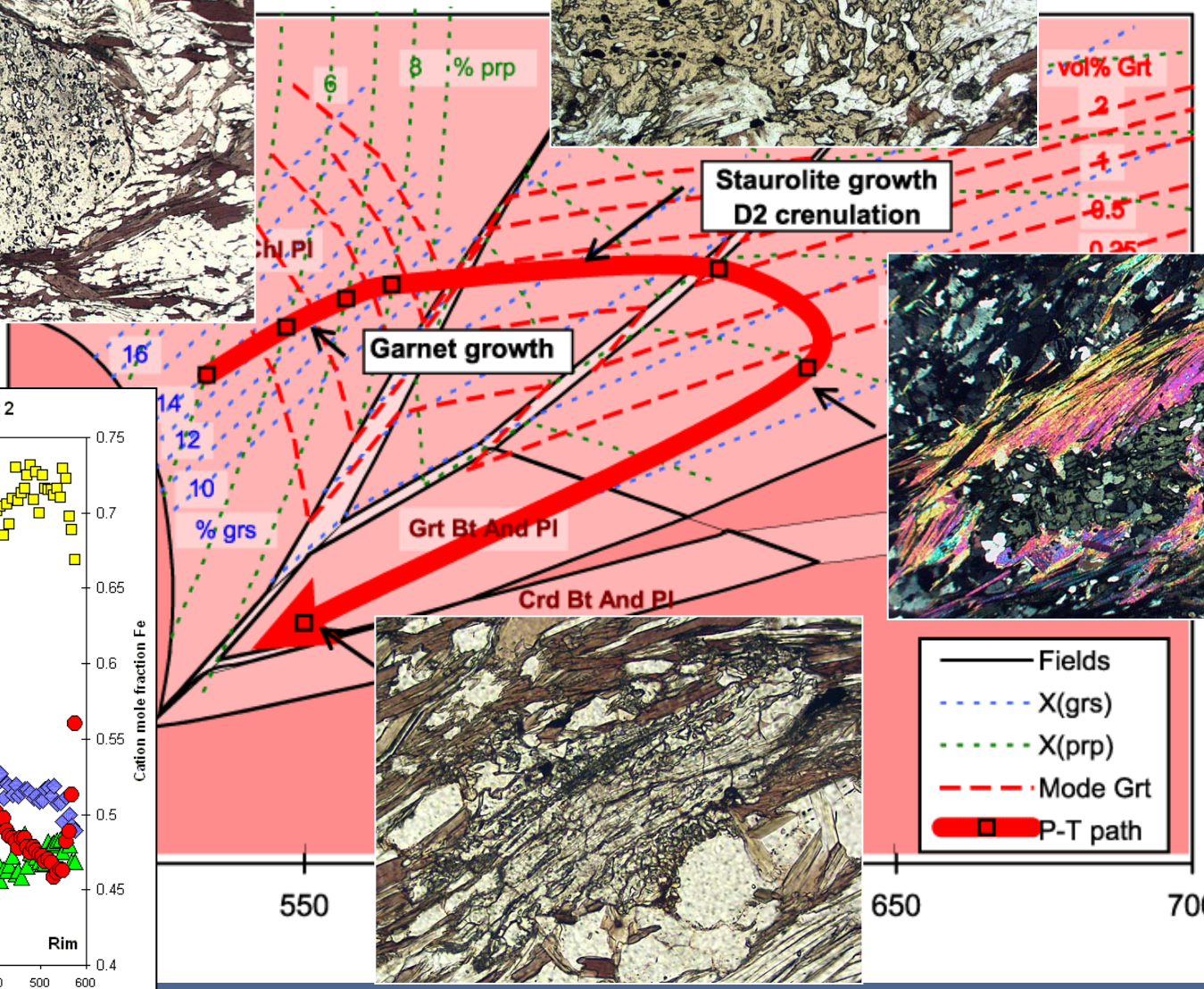
Granite sheets

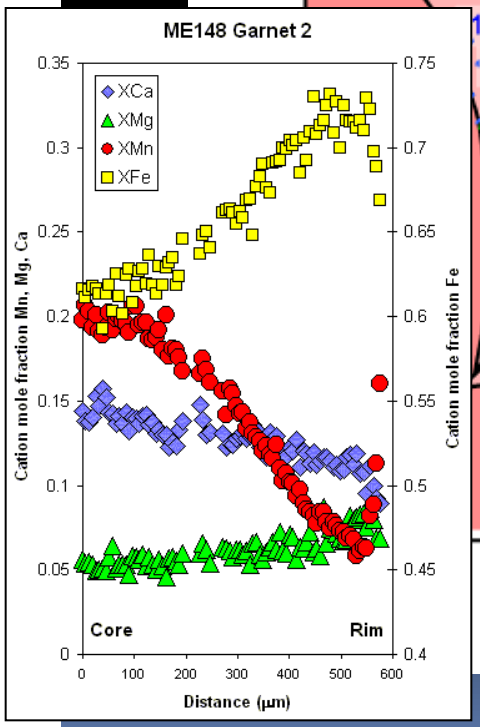
ME-148

ME-148

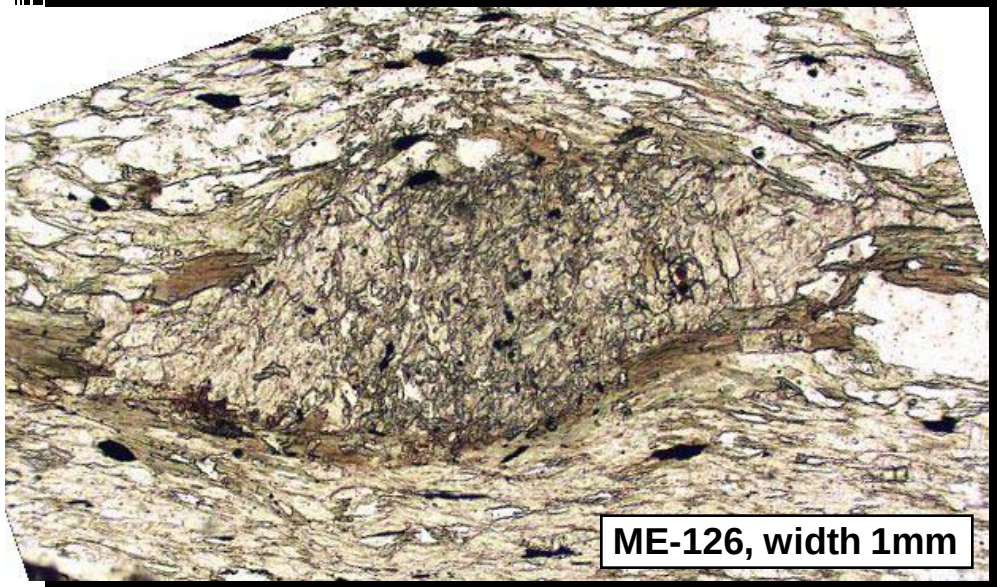


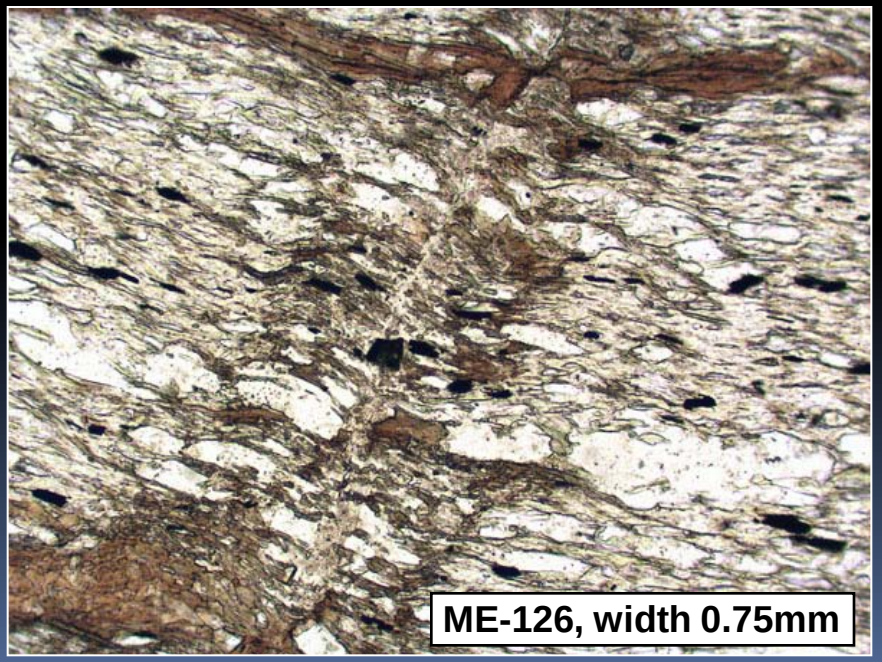



% prp
vol% Grt
Staurolite growth
D2 crenulation
Garnet growth
Grt Bt And Pl
Crd Bt And Pl
% grs
Fields
X(grs)
X(prp)
Mode Grt
P-T path
550
650
700


ME148 Garnet 2
XCa
XMg
XMn
XFe
Cation mole fraction Mn, Mg, Ca
Cation mole fraction Fe
Core
Rim
Distance (μm)

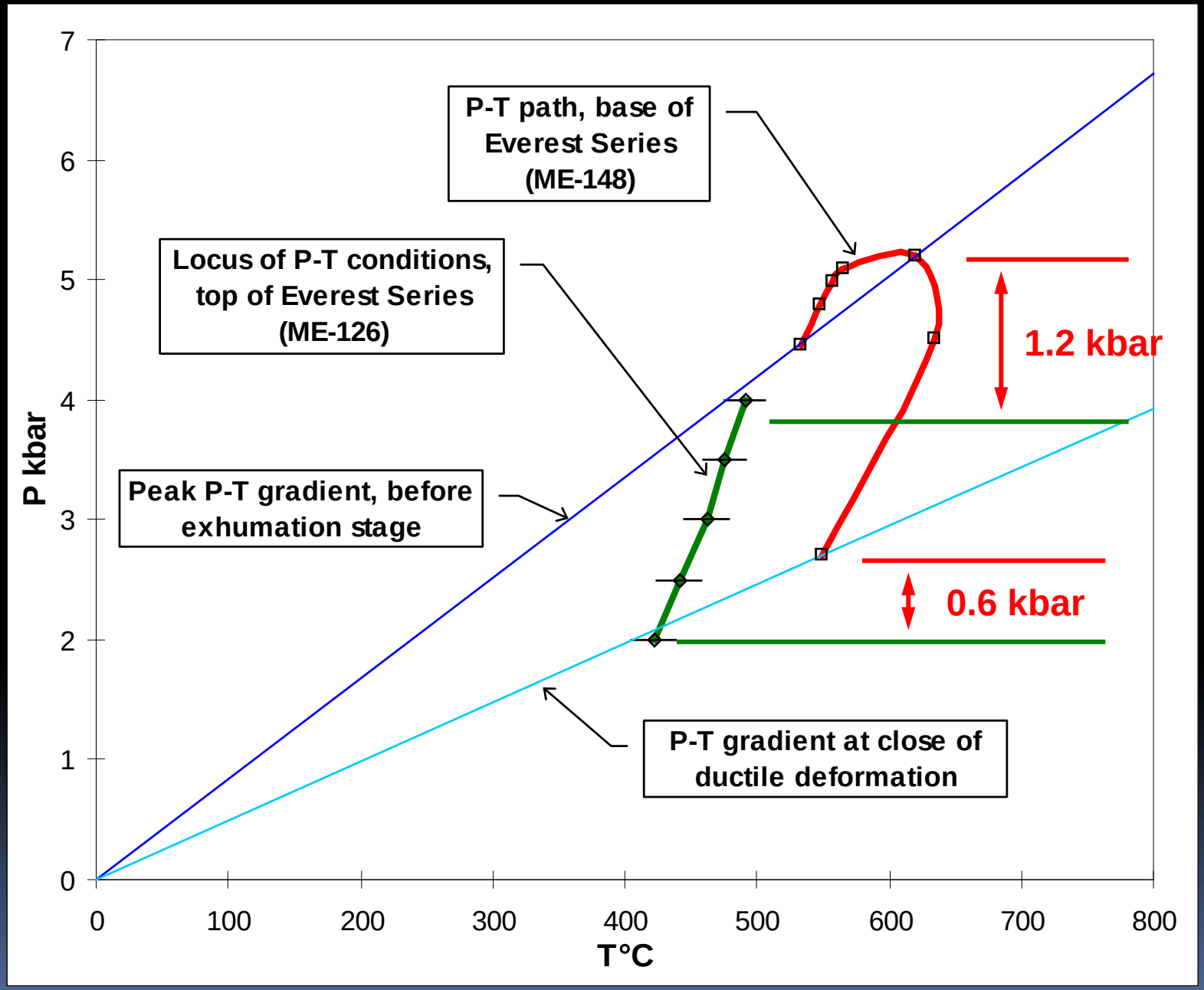
ME-126





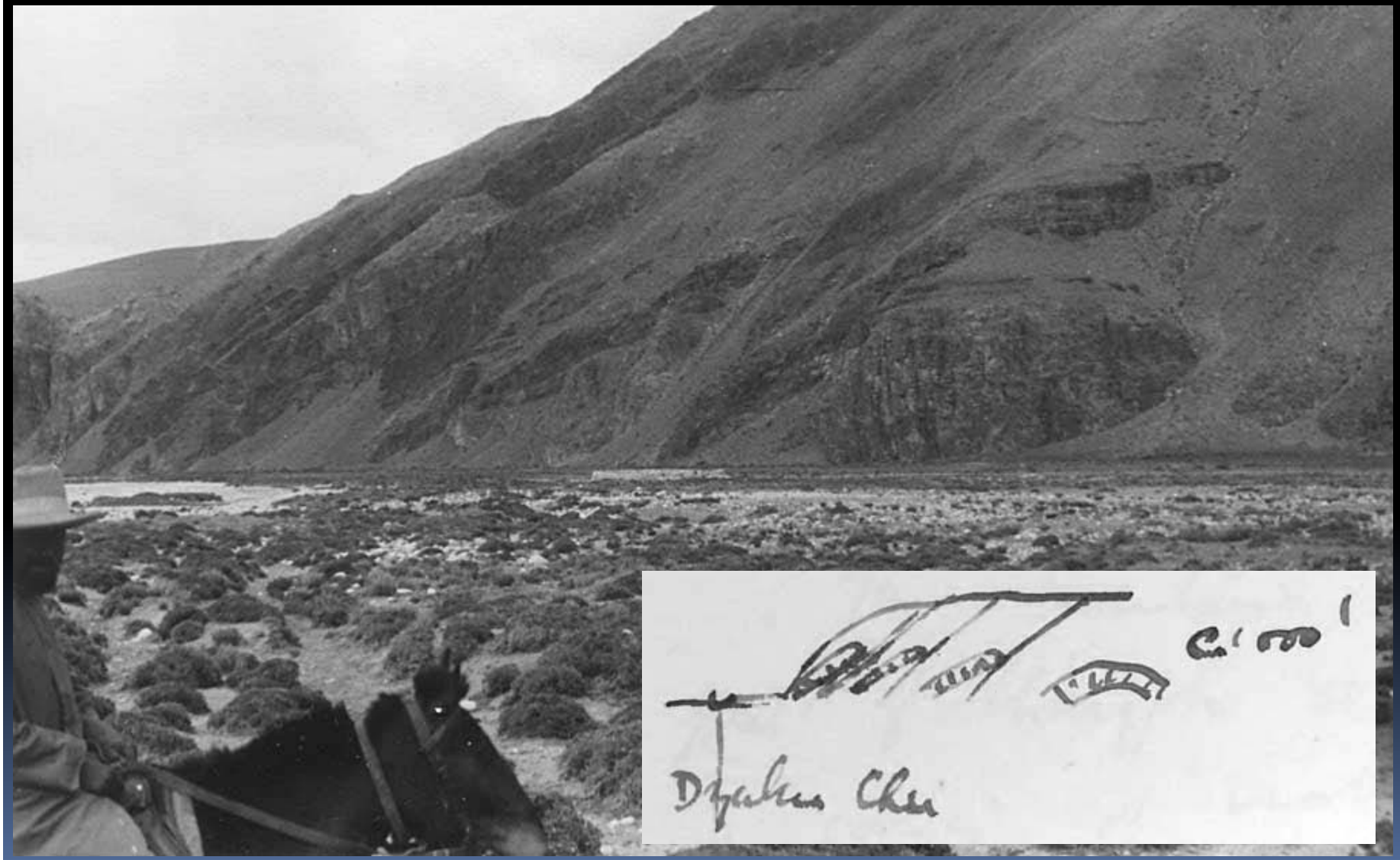
1. Pervasive top-to N simple shear (σ-porphyroclasts)
2. Top-to-N shear with extension (shear band fabric)
3. Extensional veins

… all at relatively high T

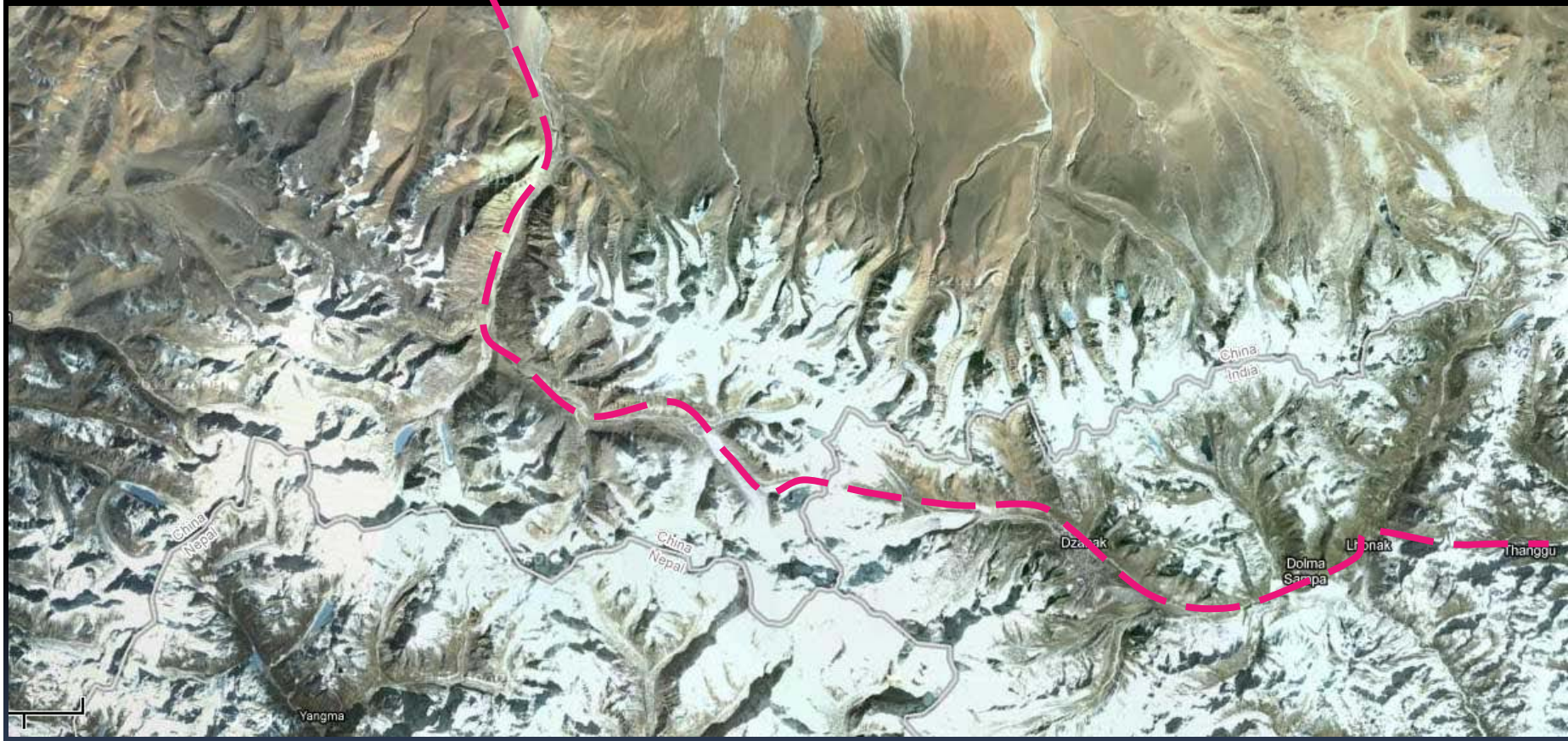

P-T path, base of Everest Series (ME-148)
Locus of P-T conditions, top of Everest Series (ME-126)
Peak P-T gradient, before exhumation stage
P-T gradient at close of ductile deformation
1.2 kbar
0.6 kbar
P kbar
T°C
0
1
2
3
4
5
6
7
0
100
200
300
400
500
600
700
800

Rongbuk valley

Wager in the Dzakar Chu



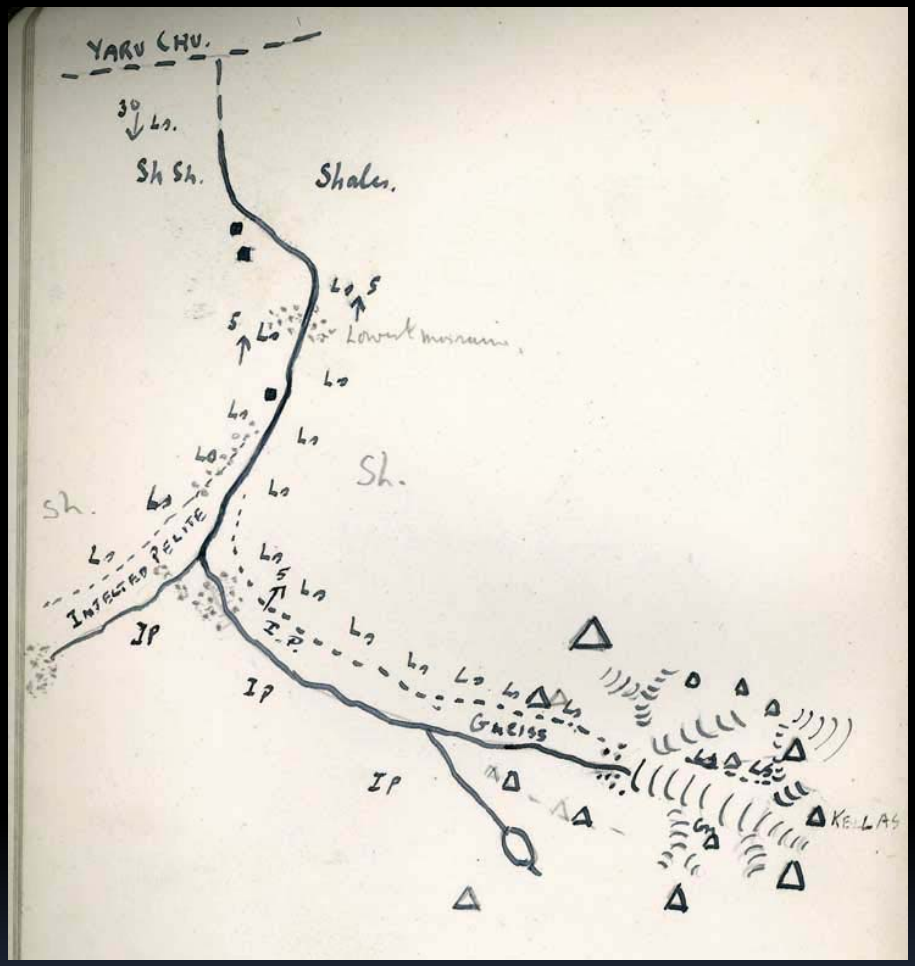
Lashar Valley (route)



Lashar Valley

Lashar Valley

- Wager's sequence:
  - Dark rock (shales)
  - Massive shattered lst (2000')
  - Yellow platy marble (Changmu monastery)
  - Pelite with granite injections >=1500'
  - Granite intrusion 2 miles long in pelite
  - Biotite augen gneiss + occasional tourmaline pegmatites

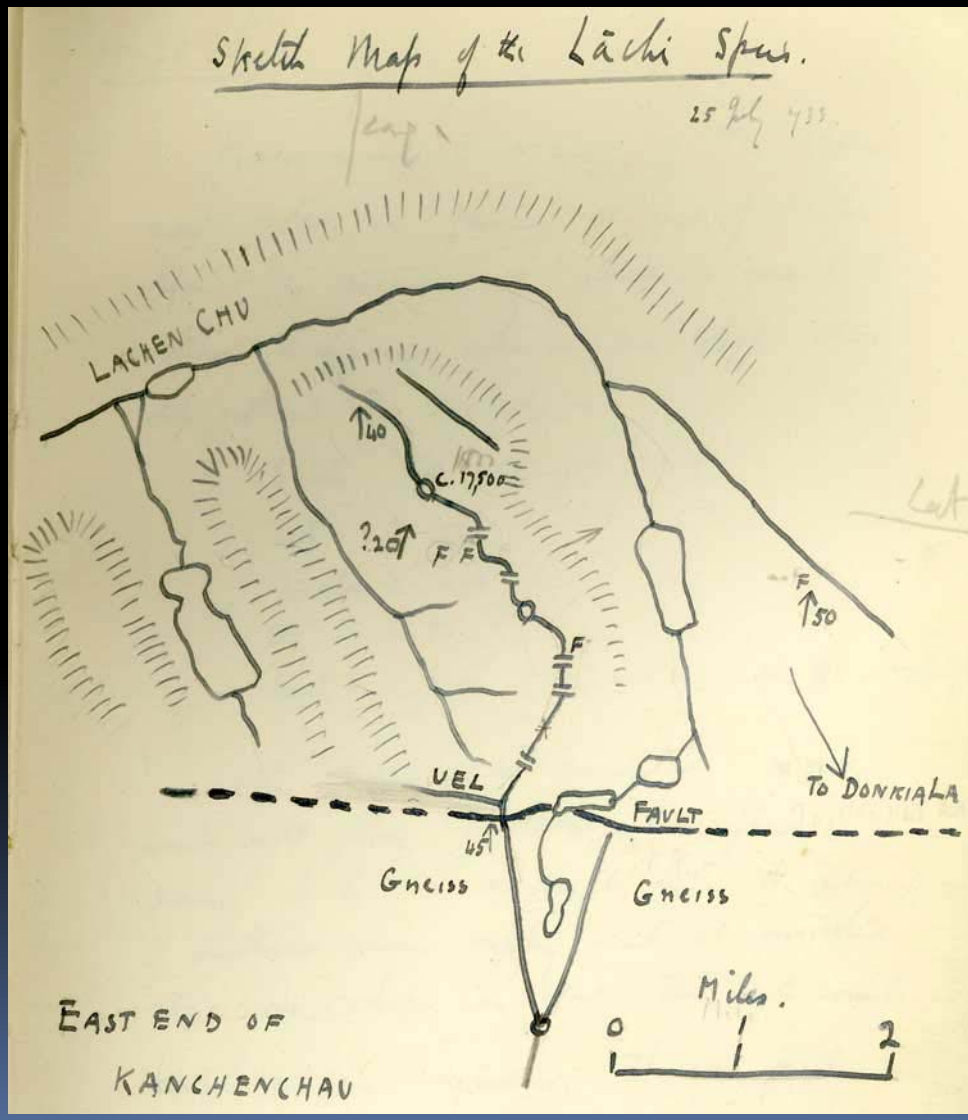


Lashar Valley

Lashar Valley N side

Northern Lachen, Sikkim

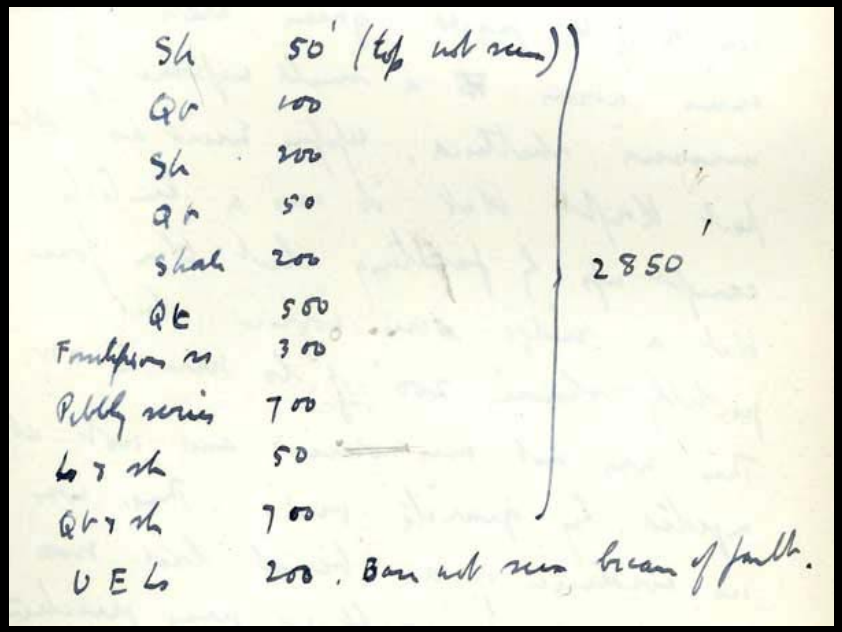
Lachi spur, Northern Lachen

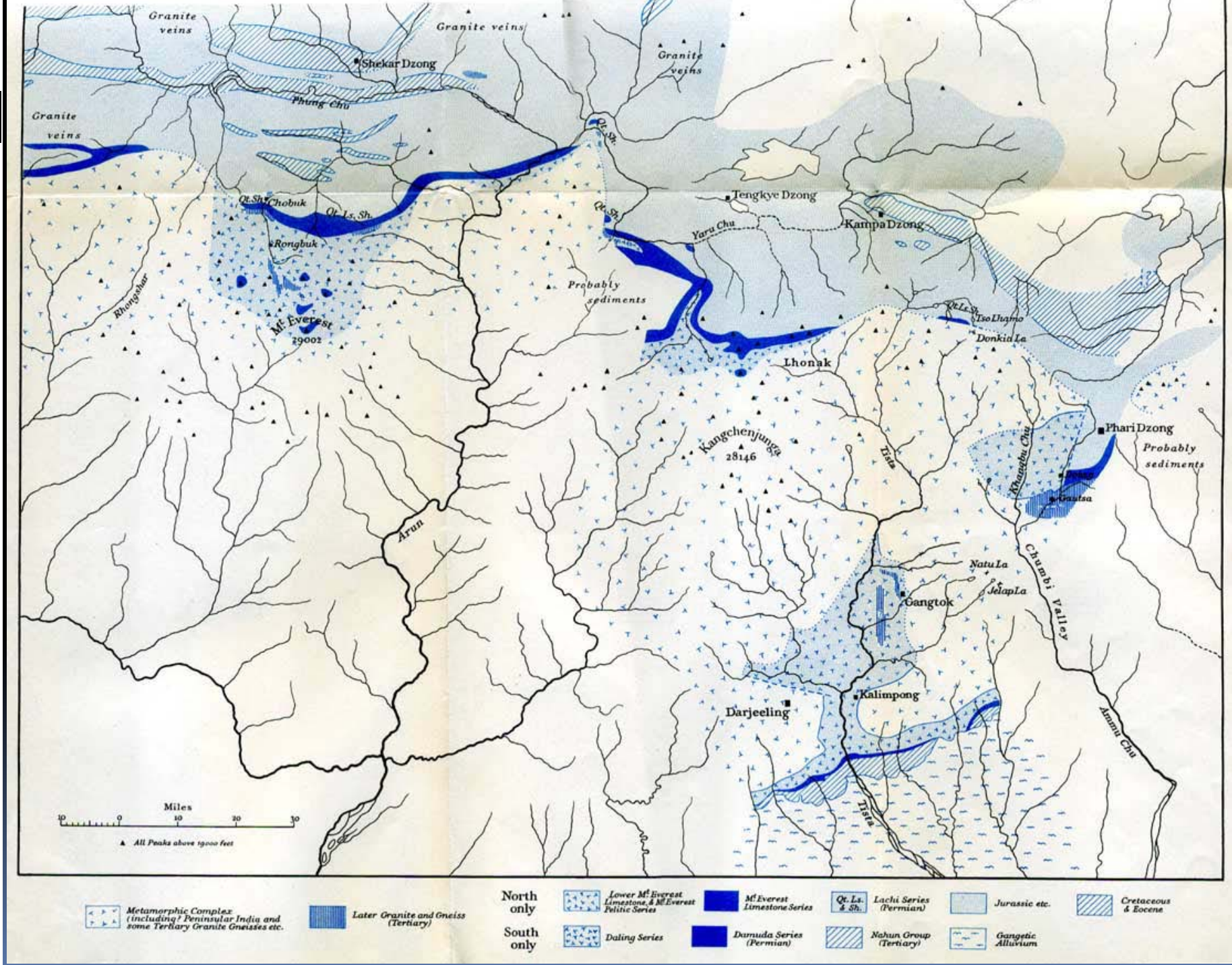


STD fault on Lachi spur

Northern Lachen

- Shale & quartzite succession (Lachi Series)
- Limestone equivalent to Everest Lst, thin (200')
- Fault zone + mylonite dipping 45 ° north
- Biotite gneiss (granitic), v little metasediment, porphyritic Bt gneiss over Donkia La
- Below to S, W-plunging structure with metasediments in core
- Further south, migmatite & Bt granite




Granite veins
Granite veins
Granite veins
Granite veins
Shekar Dzong
Phung Chu
Qt. Sh.
Qt. Sh.
Chobuk
Qt. Ls. Sh.
Rongbuk
Rhongshar
Mt. Everest
29002
Probably sediments
Tengkye Dzong
Yaru Chu
Kampa Dzong
Qt. Sh.
Qt. Ls. Sh.
Tso Dumo
Donkia La
Lhonak
Kangchenjunga
28146
Tista
Phari Dzong
Probably sediments
Khangbu Chu
Gautsa
Arun
Natu La
Jelap La
Gangtok
Chumbi Valley
Kalimpong
Darjeeling
Ammu Chu
Tista
Miles
10 0 10 20 30
All Peaks above 19000 feet
Metamorphic Complex (including? Peninsular India and some Tertiary Granite Gneisses etc.
Later Granite and Gneiss (Tertiary)
North only
Lower Mt. Everest Limestone & Mt. Everest Pelitic Series
Mt. Everest Limestone Series
Qt. Ls. & Sh.
Lachi Series (Permian)
Jurassic etc.
Cretaceous & Eocene
South only
Daling Series
Damuda Series (Permian)
Nahun Group (Tertiary)
Gangetic Alluvium