870 Ma age of South Delhi Orogeny: A study on Geochronology of the granites and the meta-sediments, NW India.

By

Subhash Singh[1]

Tapas Kumar Biswal[1]

Contact- subhchandel11@gmail.com

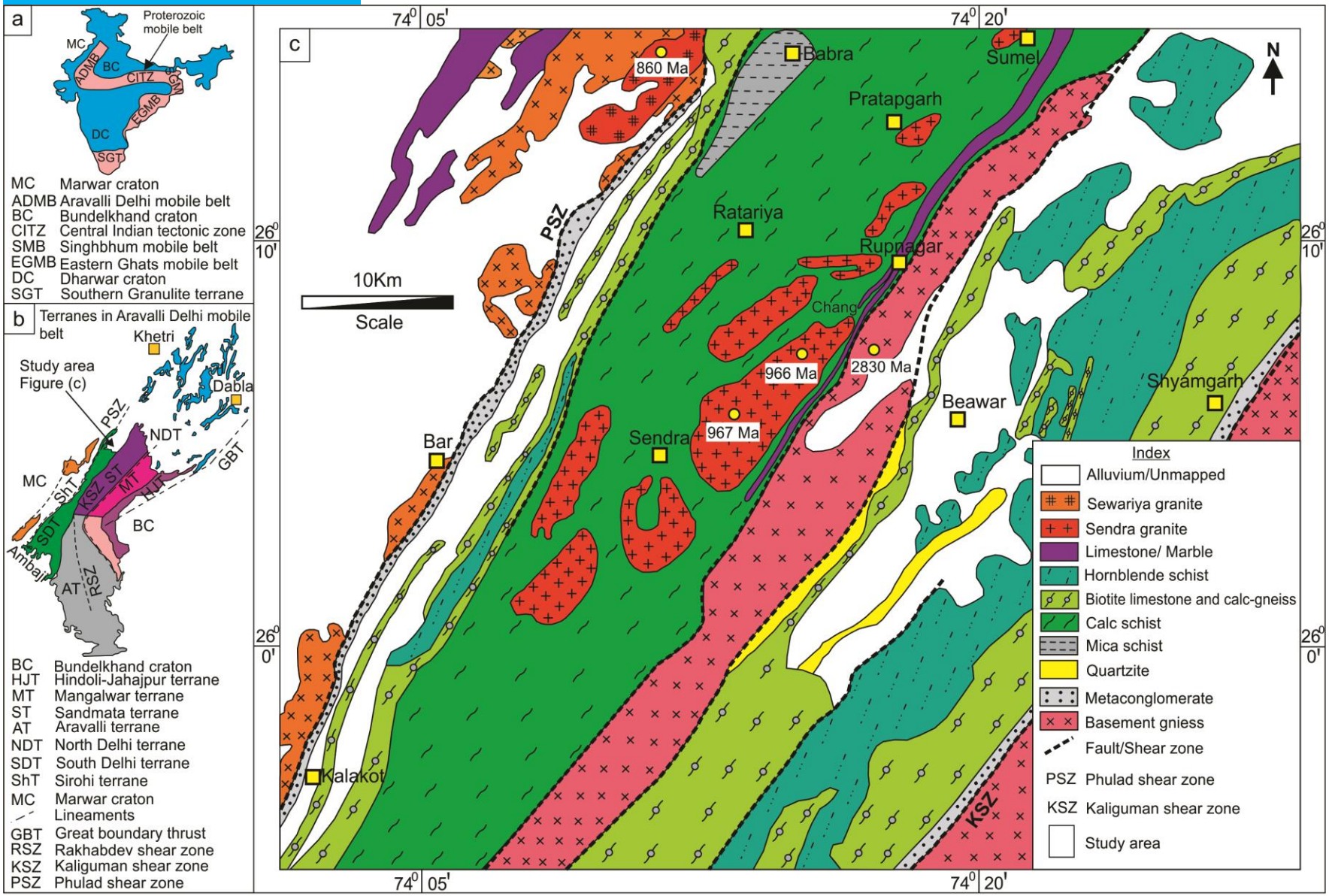
[1]Department of Earth Sciences Indian Institute of Technology Bombay- 400076

#shareEGU2020, EGU General Assembly 2020

Outline of the presentation

- Introduction and geology of study area
- Objectives
- Methodology
- Deformation in the study area
  - Three phase folding
  - Shear zones
  - Ductile shearing
- Results
  - Zircon dating
  - Monazite dating
- Discussion

Introduction



Part of lithological map of Aravalli range (S. Singh et al.,2020, Springer Nature Switzerland AG 2020).

Objective

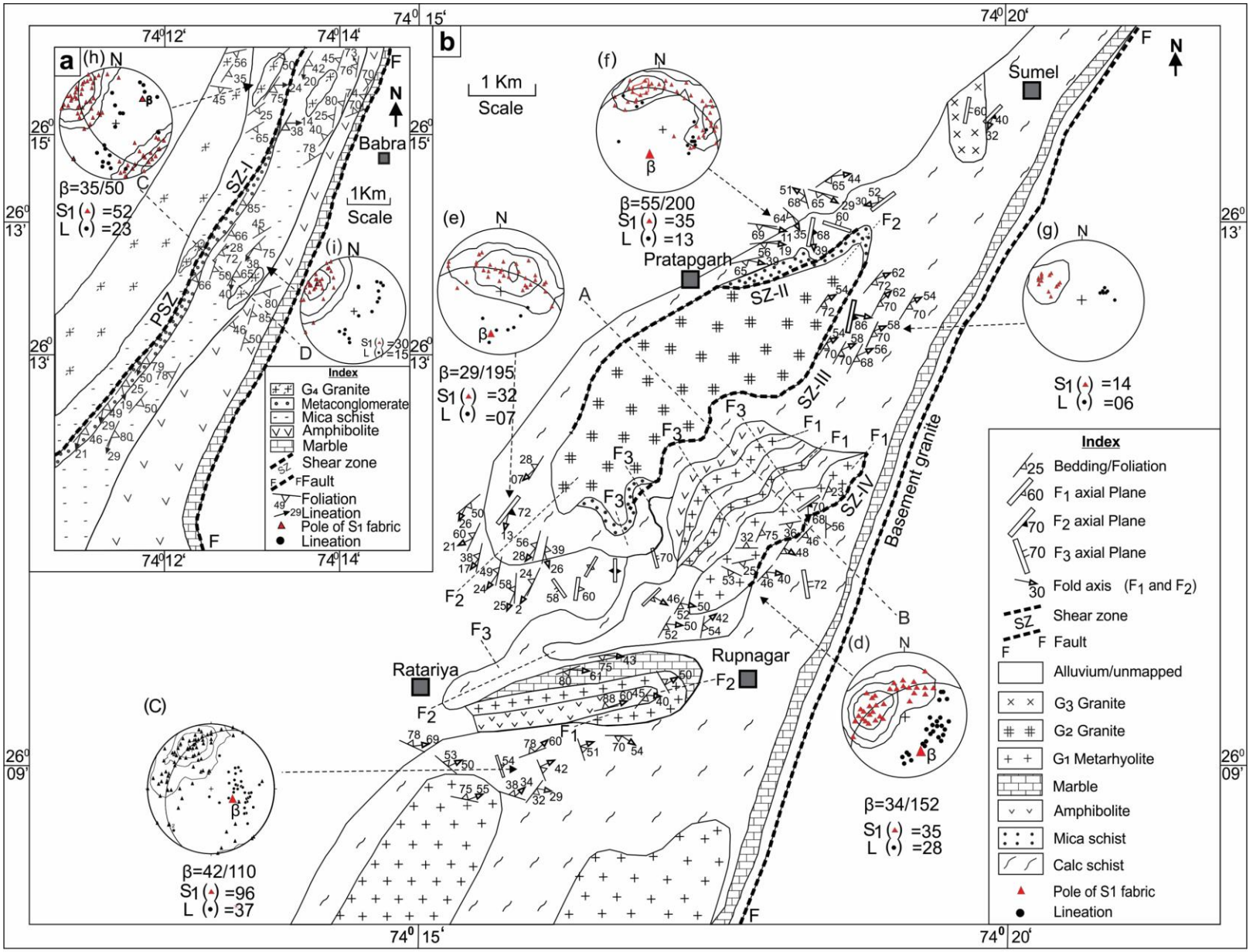
- To establish chronological order of different granitic intrusions and their relationship with the tectonic history of the area.

Methodology

- We have mapped the area on an enlarged scale (1:10,000) in parts of Survey of India toposheets, 45J/3,4,7,8 between Roopnagar and Babra.
- Different litho-units were mapped and structural data related to different generations of folding were collected.
- We distinguished different generations of folding based on overprinting relationship of strain fabric and interference pattern.
- Four shear zones (SZ-I-IV from west to east) were mapped and oriented samples were collected.
- shear sense study (on XZ section, parallel to stretching lineation and perpendicular to foliation).

- **Concordia age is calculated with 206Pb/238U and 207Pb/235U ratio by using U-Pb data (SHRIMP method) of G1, G2, G3 and G4 granites.**

- **Monazite dating of the garnet-staurolite-quartz-feldspar-biotite schist and granitic pebble from the basal conglomerate zone.**

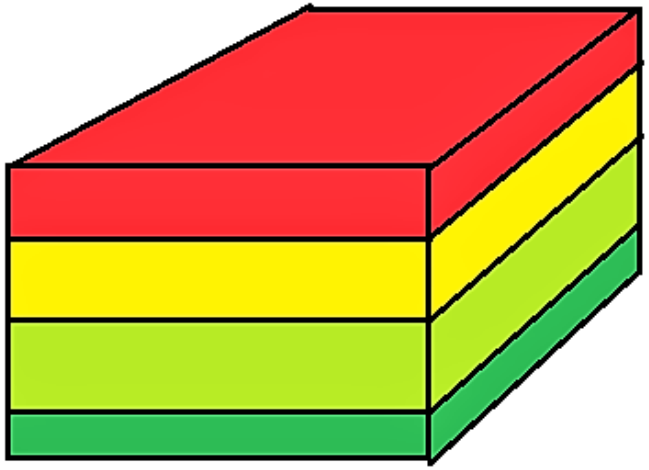


Detailed structural map of the study area (S. Singh et al.,2020, Springer Nature Switzerland AG 2020).

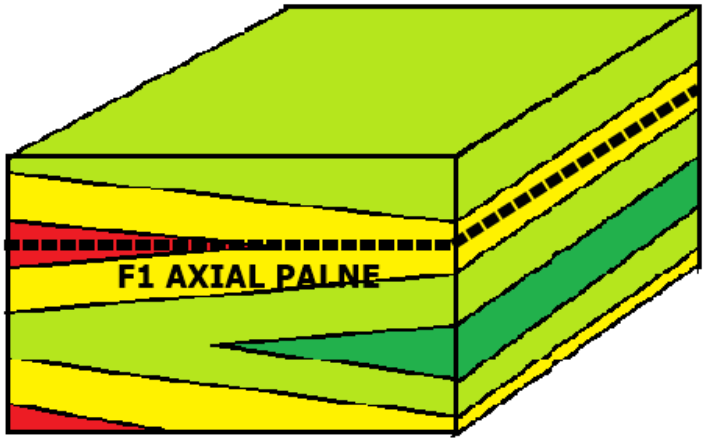
Model of three phases of deformation in study area

N

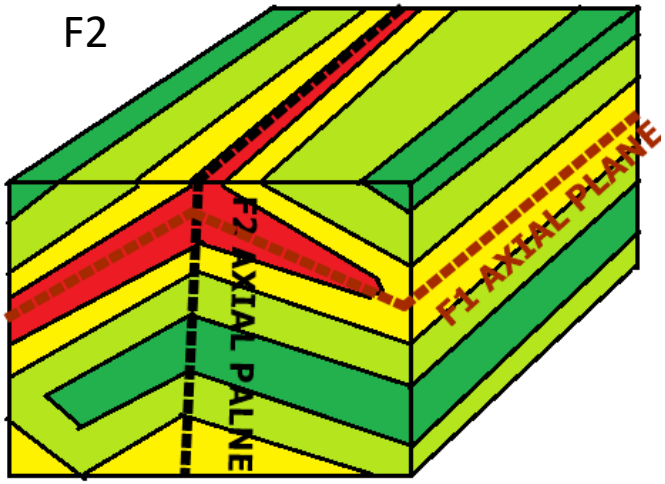
Undeformed



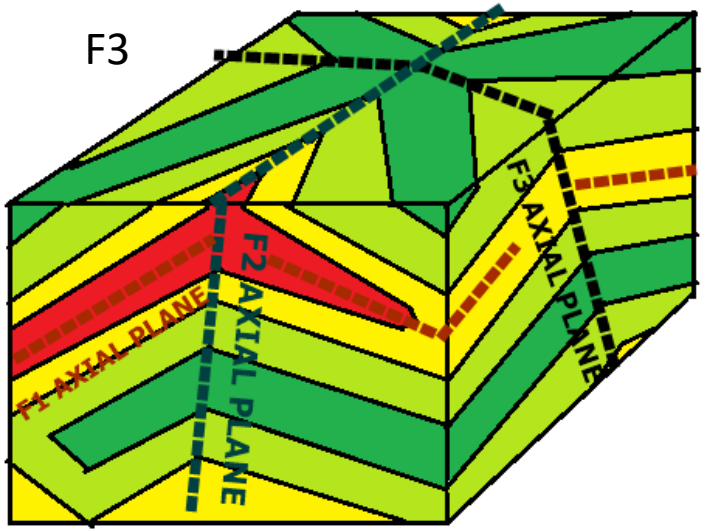
F1



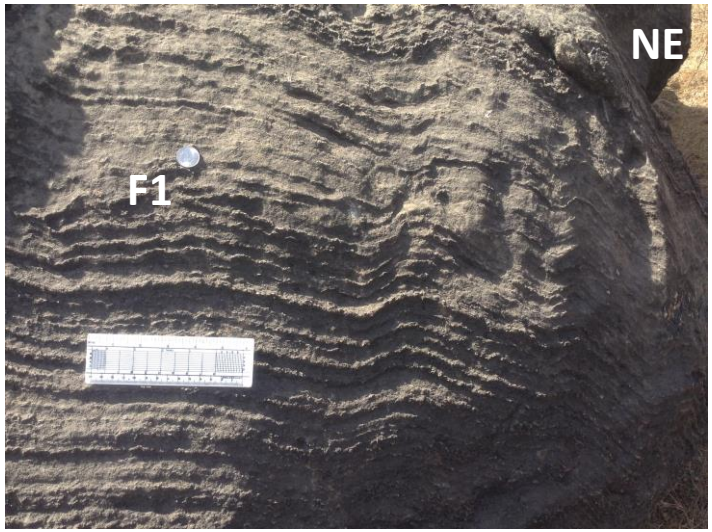
F2

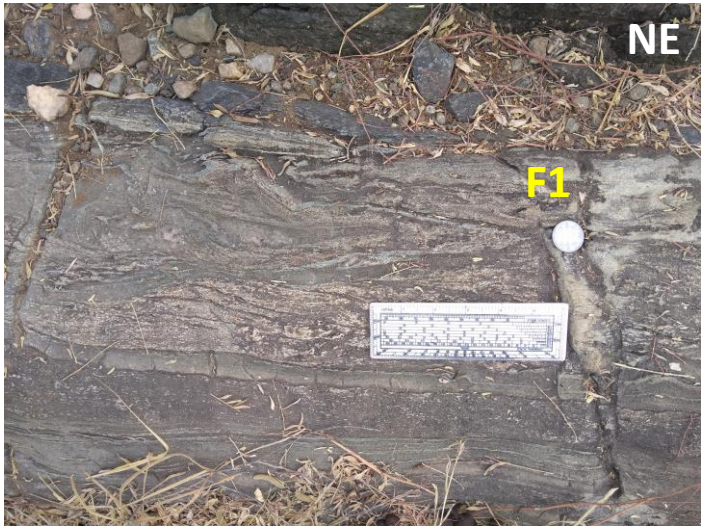


F3

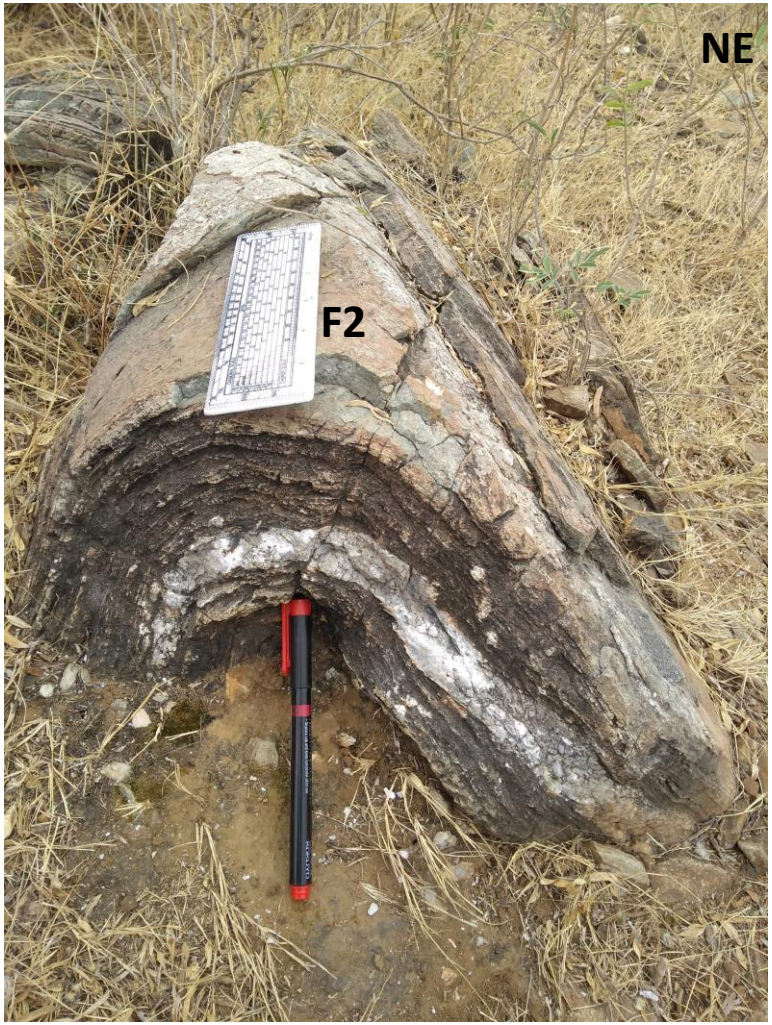


Field photographs of F1 Folds(Recumbent/ Reclined)

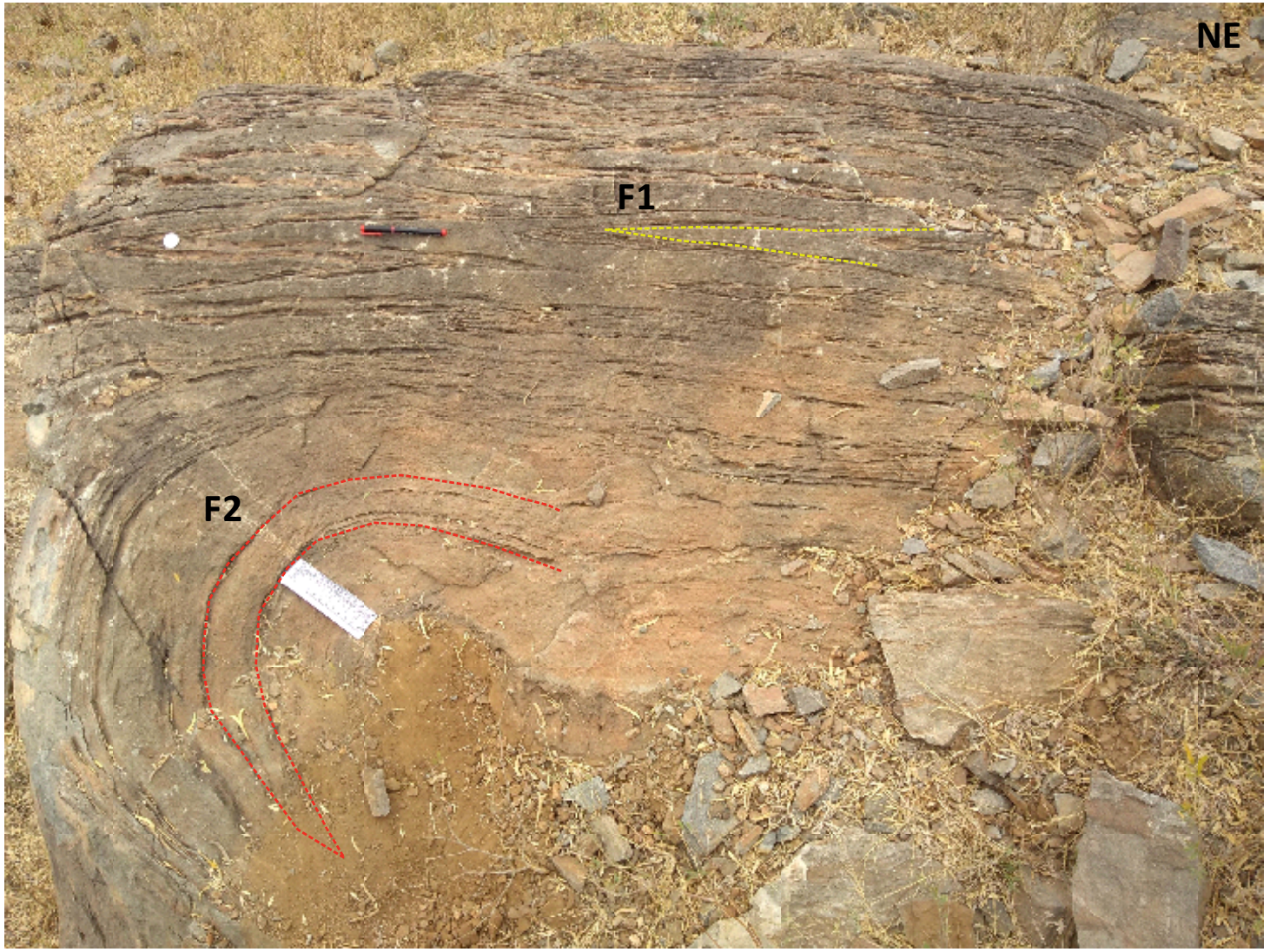




Field photographs of F2 Folds

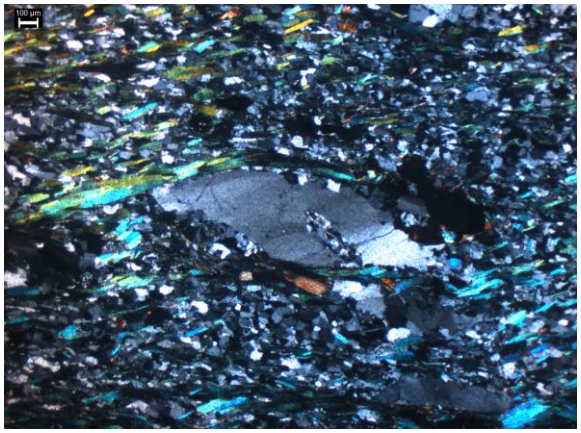


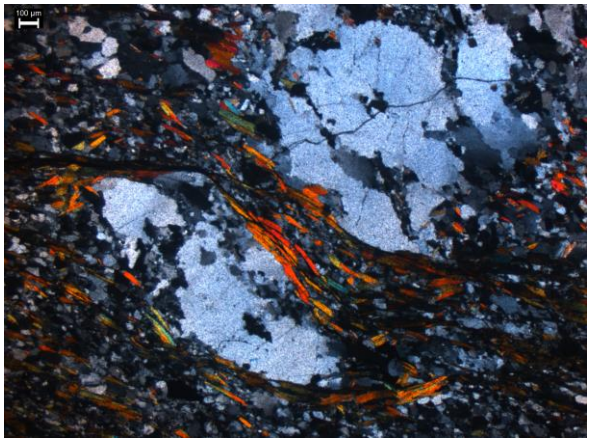
Field photograph of type 3 interference pattern

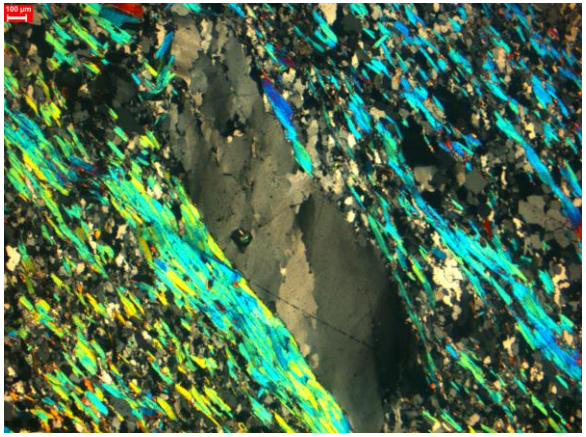


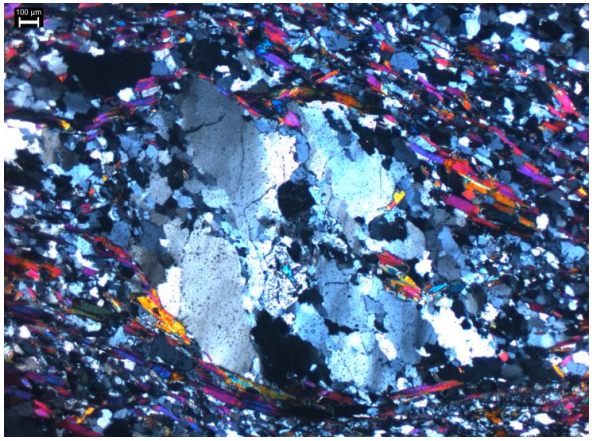
Field photograph of F3 Fold

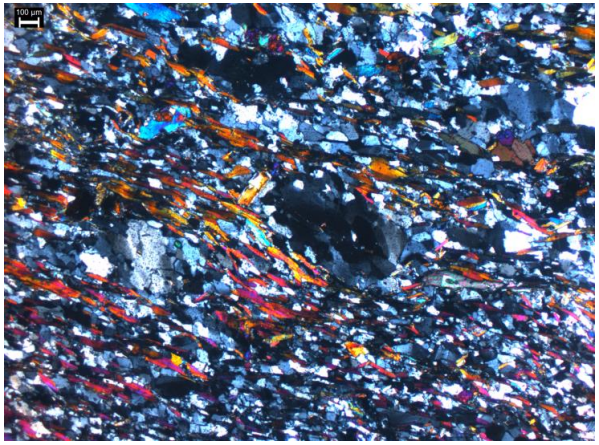
F2 Ductile shearing in mica schist

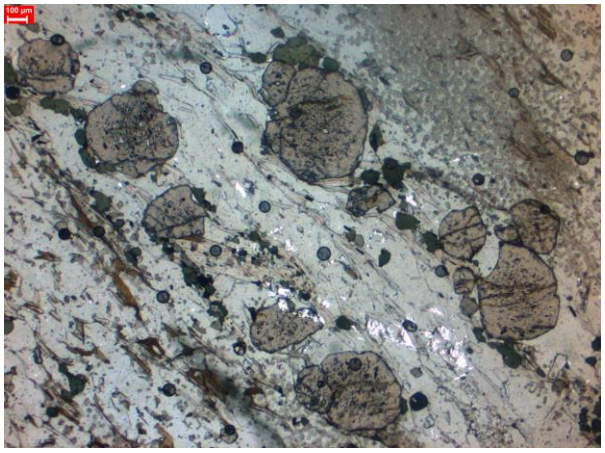




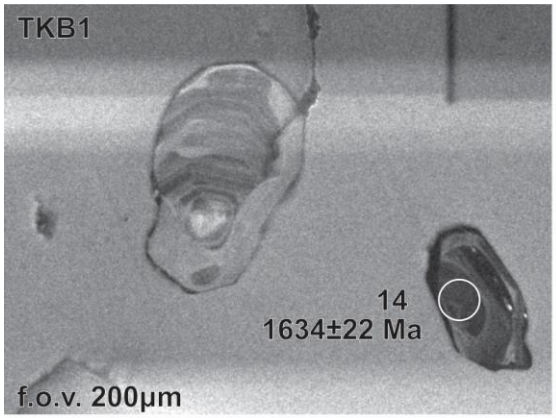


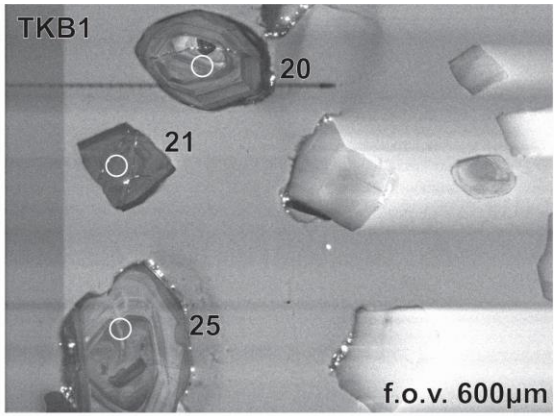


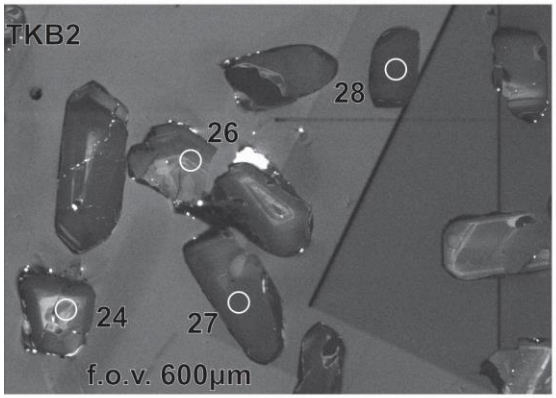


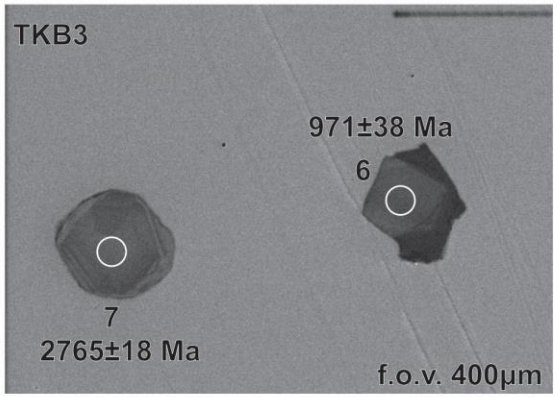


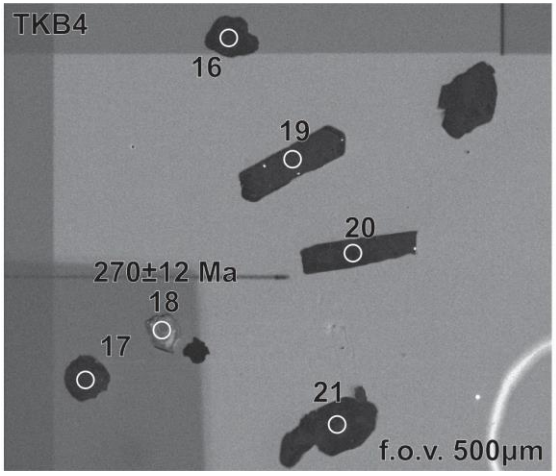
CL Images of Zircon

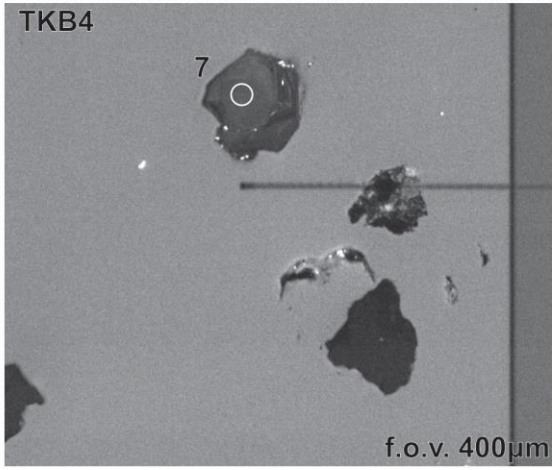












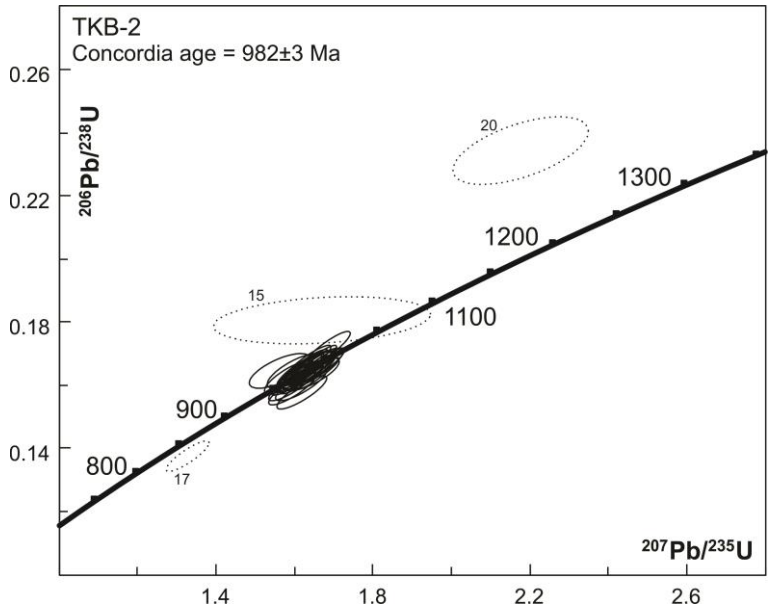
Earth Sciences

Results

TKB-2(G1)

- The data plot in a well-define cluster on Concordia (Figure), with the exception of TK2.15 and TK2-17, which record the highest f_{206} values and plot off Concordia.

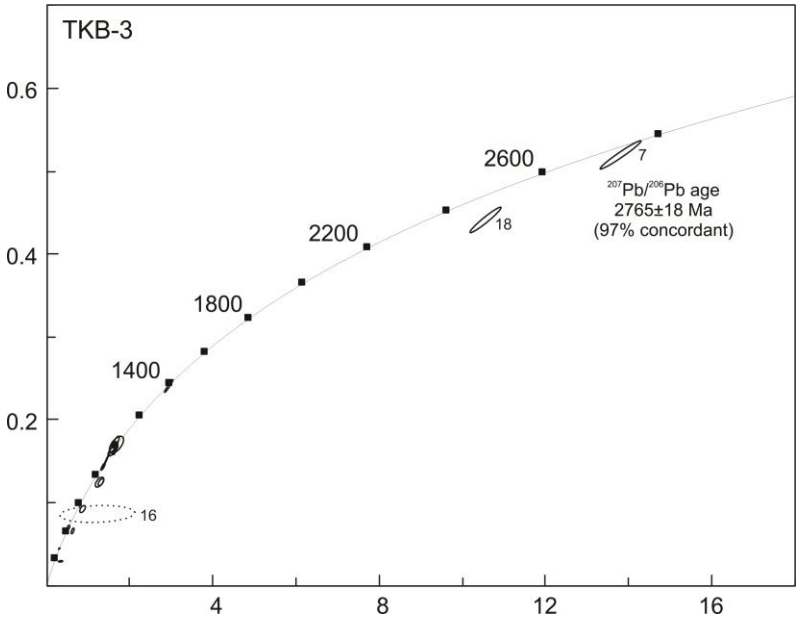
- The concordant population of 27 zircon define a Concordia age of 982±3 Ma, which is the best approximation of the emplacement age of the granite protolith in sample TKB-2

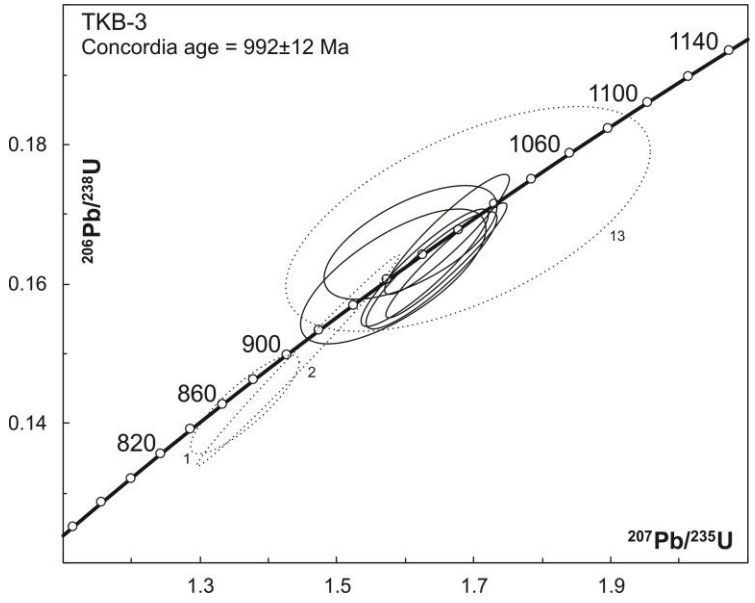


TKB-3(G2)

- Two zircon grains record older $^{207}Pb/^{206}Pb$ ages, with the one near-concordant point (TKB3.7) giving an age of 2765±18 Ma. These are considered to record some xenocrystic components in the granite protolith (Figure).

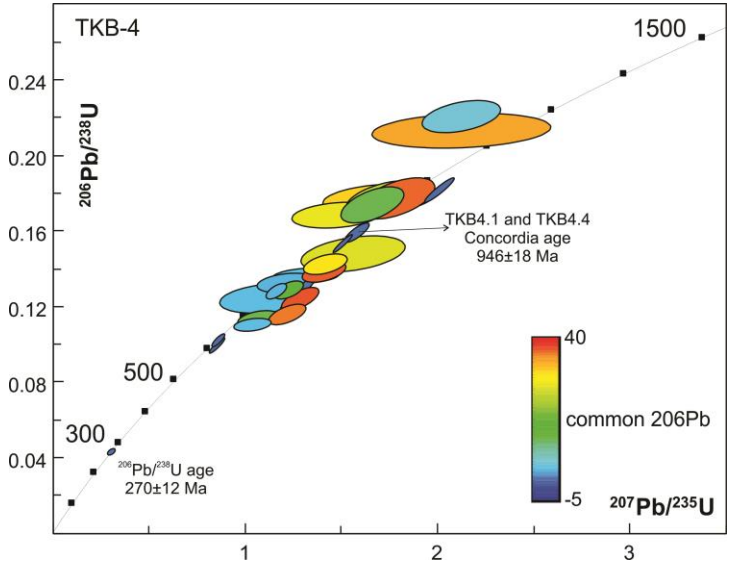
- The remaining points plot cluster with a Concordia age of 992±12 Ma

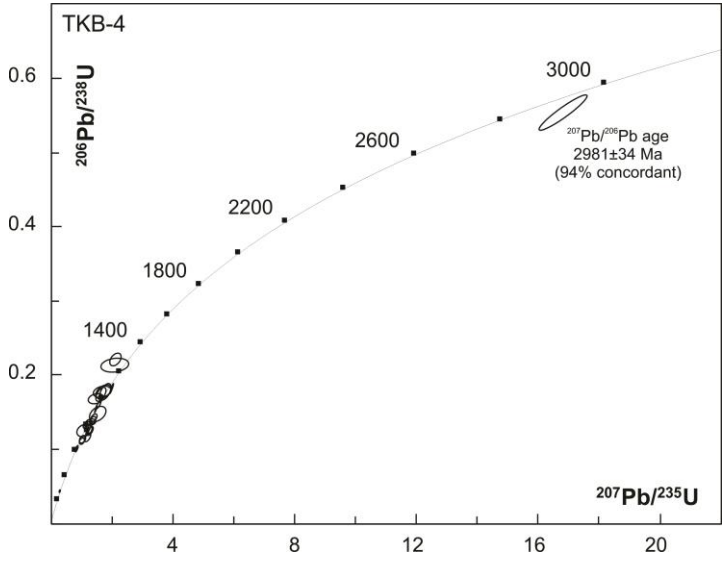




TKB-3(G4)

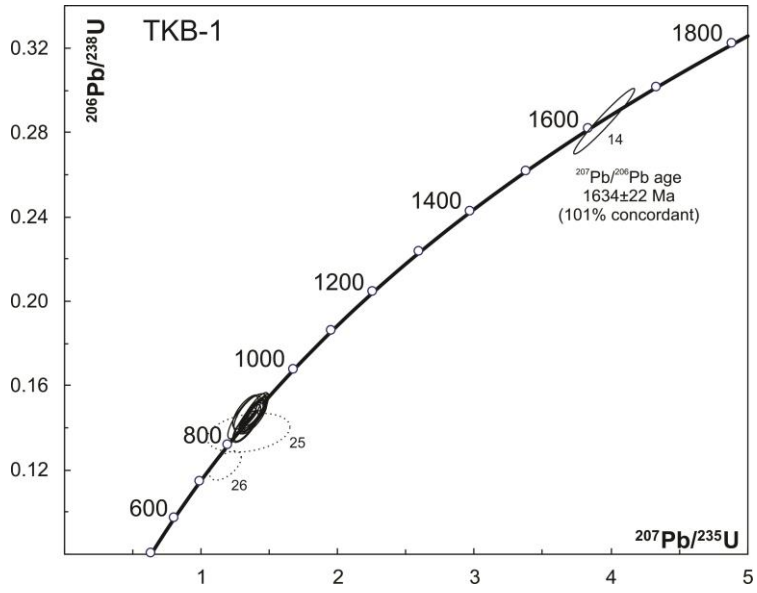
- One analysis yielded an older age of ca 3.0 Ga, but plots slightly under Concordia .This grain is interpreted to reflect a xenocrystic component in the granite dyke.
- The oldest cluster of concordant grains in the population provide a Concordia age of 946±18 Ma, which could reflect the emplacement age of the granite dyke.
- One zircon (TKB4-7), analysed twice during the session, provides a concordant data point at 270±12 Ma, This young grain would put the age of emplacement of the granite dykes at 270 Ma, with the older populations.

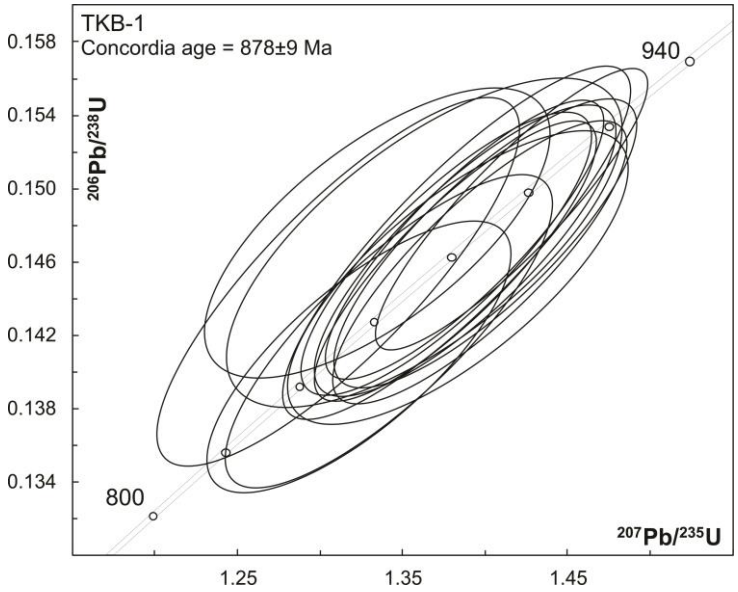




TKB-1(G4)

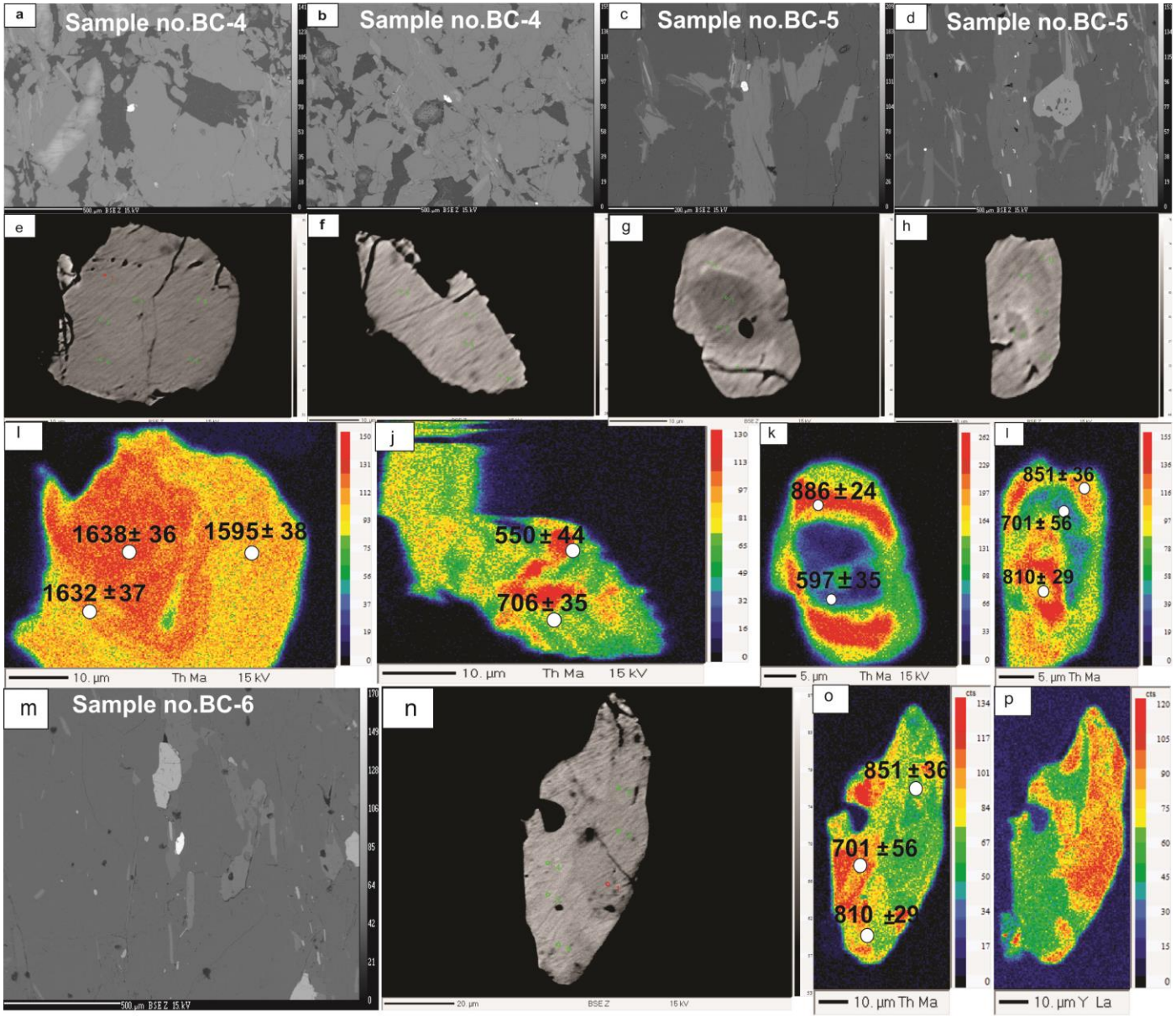
- The data plot in a well-defined cluster on Concordia, with two analyses within that population plotting with larger errors and off Concordia, corresponding to the two analysis with the highest f_{206} (TKB1-25 and TKB1-26.
- The concordant points correspond to a Concordia age of 878±9 Ma, which we take to be the best estimate for the emplacement age of the granitoid.
- One analysis, TKB1-14, plots well-away from the Concordia age, with a $^{207}Pb/^{206}Pb$ age of 1634±22 Ma.





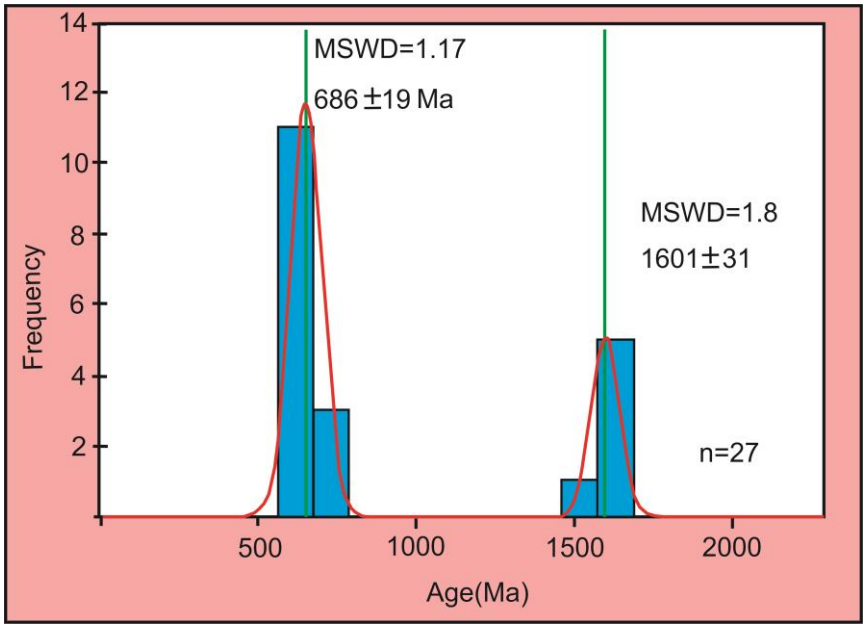
Monazite Dating

- **EPMA Th-U-total Pb monazite geochronology of the garnet-staurolite-quartz-feldspar-biotite schist from the basal conglomerate zone shows three distinct ages, ca. 1600Ma, 850 Ma and 700 Ma.**

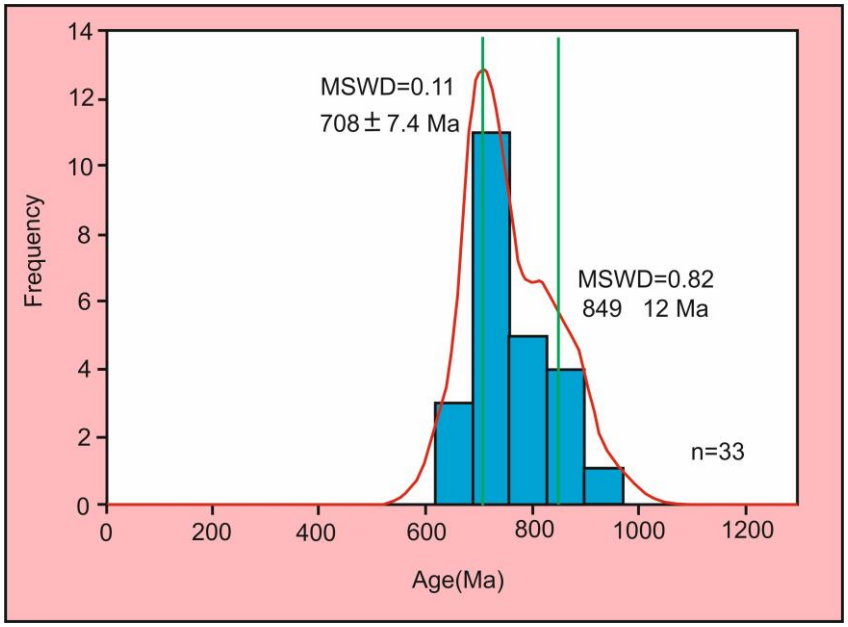


BSE images and X-ray mapping images of monazite grains of Bar meta-conglomerate samples.

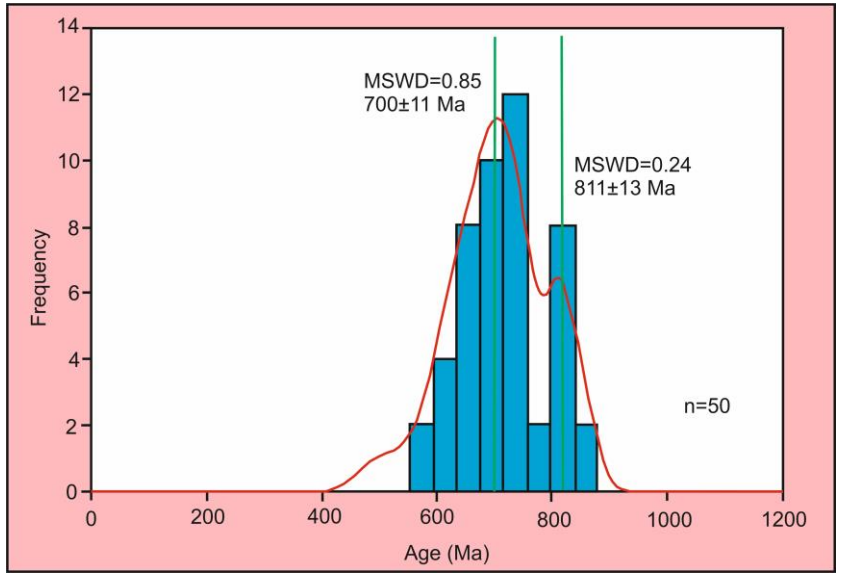
Relative probability plots (using Isoplot add-in for Excel, 64)



BC-4



BC-5

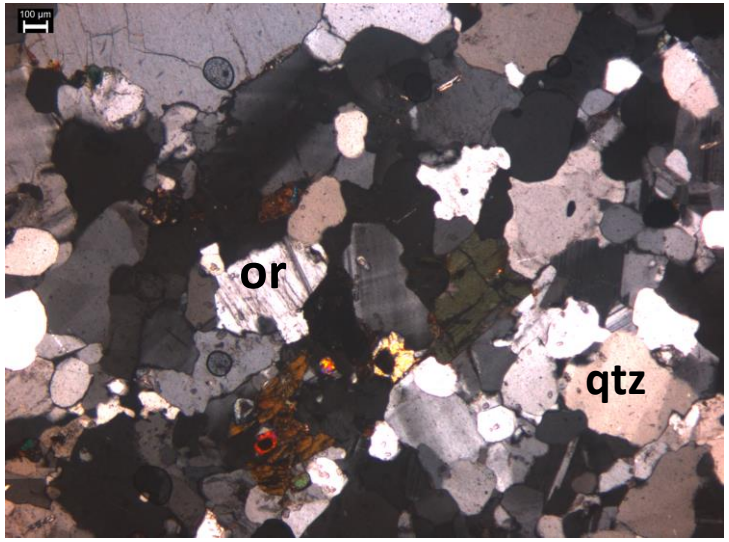


BC-6

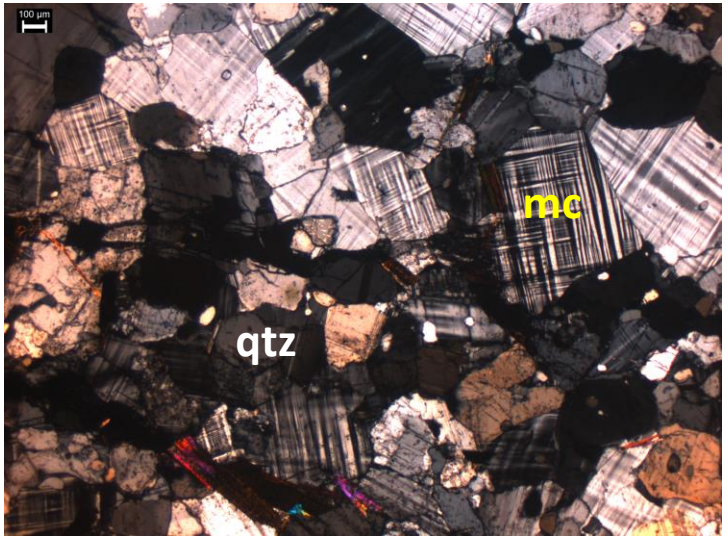
Discussion

- Three stages of deformation(D_{1-3}).
- Four types of granite plutons (G_{1-4}).
- The D_1 deformation produced F_1, reclined/recumbent folds with S_1 axial planar fabric in greenschist facies metamorphic condition.
- The D_2 deformation produced NE-SW trending F_2 folds coaxial with F_1(type 3 interference pattern), crenulations and F_2-axial parallel ductile shear zones.
- The D_3 deformation produced NW-SE F_3 folds, which superimposed on F_1 and F_2 to create type 1 and 2 interference pattern.
- U-Pb data (SHRIMP method) of G_1, G_2 and G_4 granites yield Concordia age calculated with $^{206}Pb/^{238}U$ and $^{207}Pb/^{235}U$ ratio at ~982 Ma, ~992 Ma and ~878 Ma respectively.

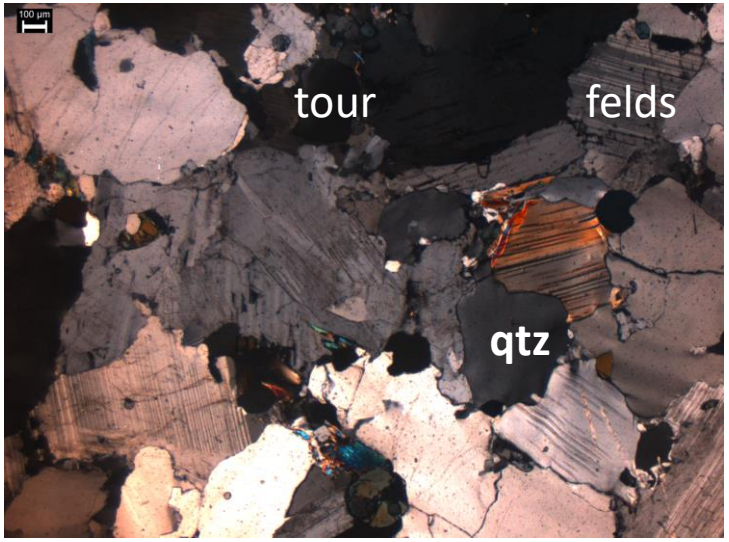
Petrographic images of granites in study area



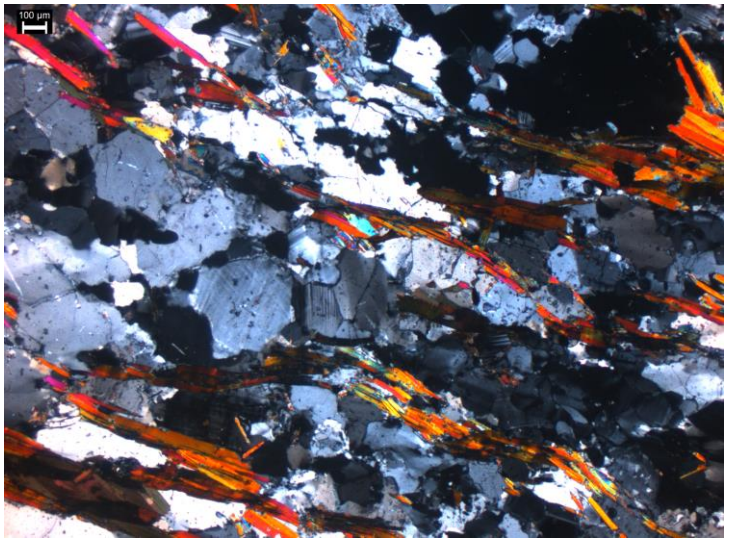
Rupnagar granite (G1)



Pratapgarh granite (G2)

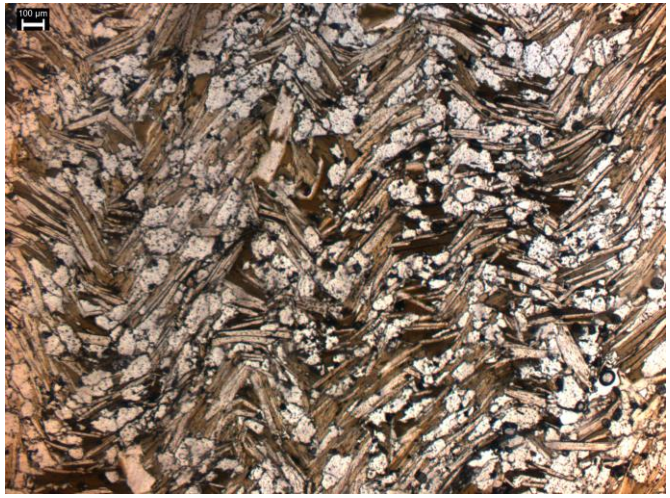


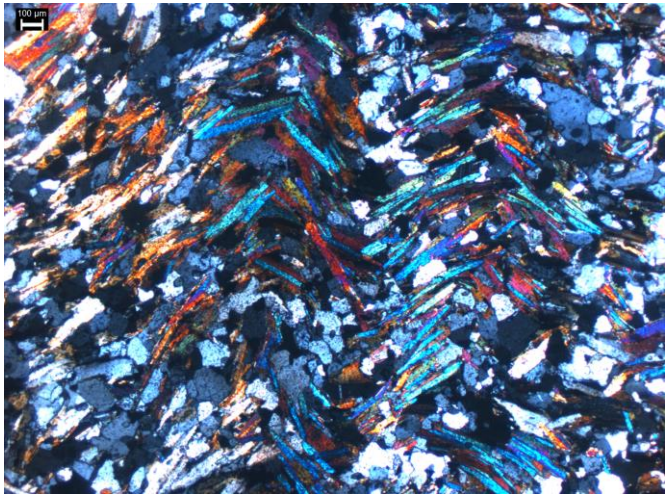
Sumel granite (G3)



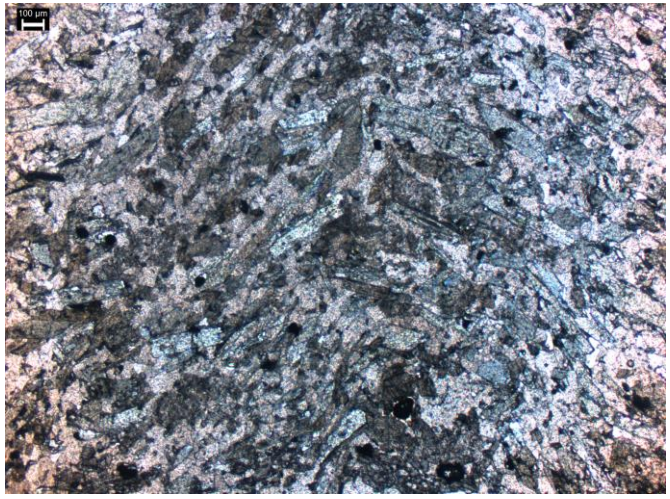
Bar-Birintia-Sewaria granite(G4)

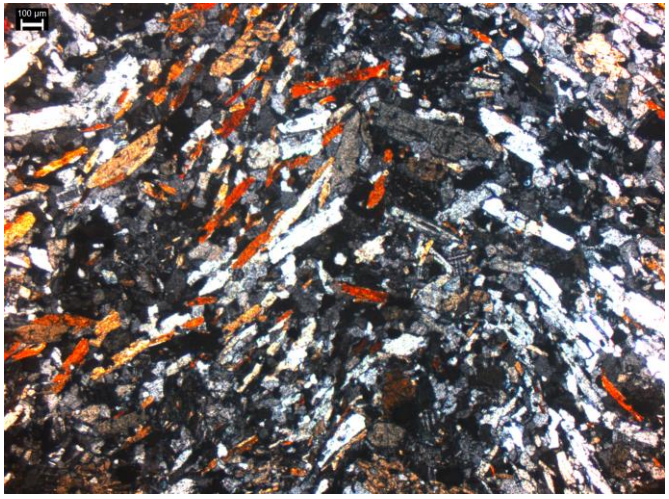
Petrographic images of F2 Crenulation(Mica schist)



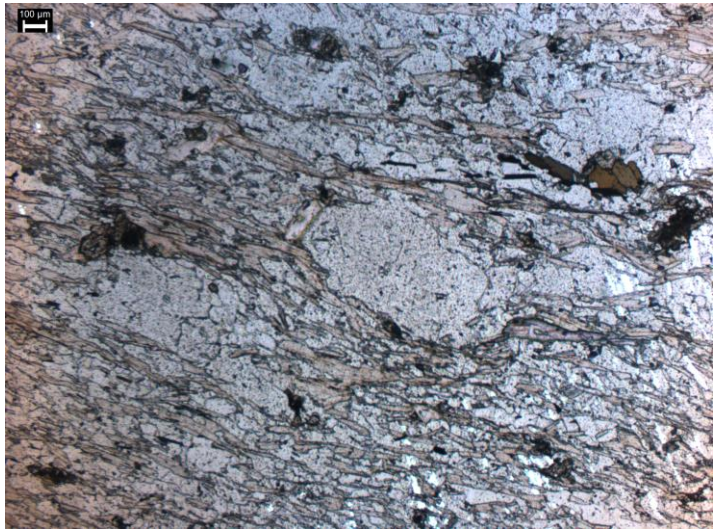


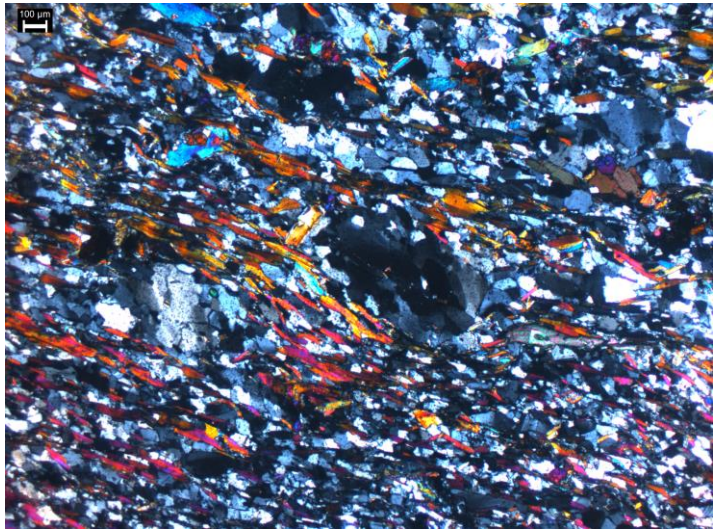
Petrographic images of F2 Crenulation(Calc schist)

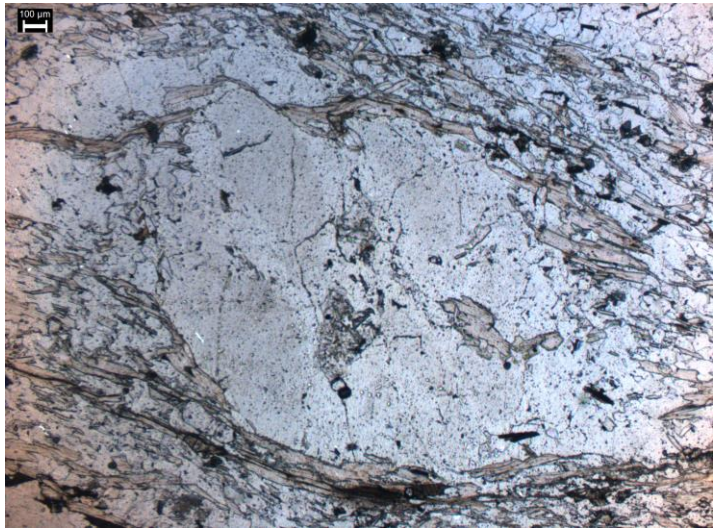


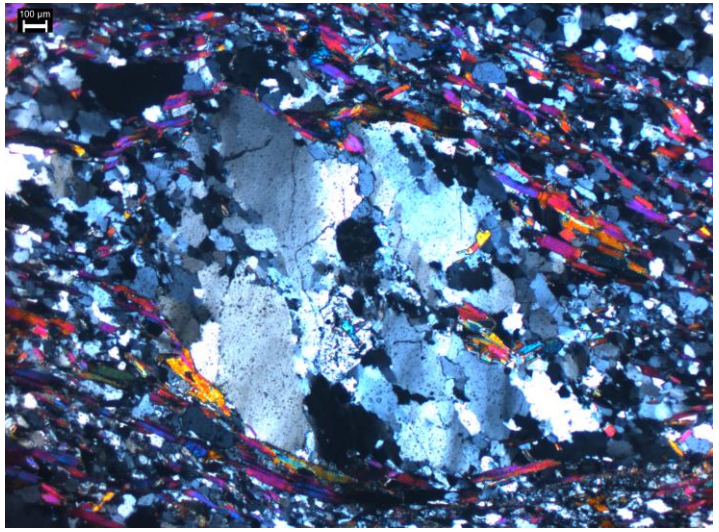


Petrographic images of F2 Ductile shearing in mica schist









- **EPMA Th-U-total Pb monazite geochronology of the garnet-staurolite-quartz-feldspar-biotite schist from the basal conglomerate zone shows three distinct ages, ca. 1600Ma, 850 Ma and 700 Ma.**

- **Correlating with granite SHRIMP age, the ~ 864 Ma corresponds to Delhi metamorphism and D1 deformation (~ 870 Ma).**

- **We interprete that the G_4 granite is sytectonic and G_{1-3} were pre-tectonic to D_1 deformation.**
- **Thus the South Delhi orogeny is constrained by the age of G_4 granite at ~ 878 Ma (~ 870 Ma).**

- **The G_{1-3} granites are pre- Delhi orogeny and probably constrain the age of rifting of the Delhi basin.**

- **The event ca. 1600 Ga probably belongs to pre-Delhi age, which is observed in nearby pre-Delhi localities like Sandmata terrane.**

- **The $G_{1\text{-}3}$ granites are pre- Delhi orogeny and probably constrain the age of rifting of the Delhi basin.**

Thank You!